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An ecological study of the foraminifera of Mason Inlet, North Carolina

Daniel N. Miller Jr.

Department:

AN ECOLOGICAL STUDY OF THE FORAMINIFERA OF MASON INLET, NORTH CAROLINA

BY

DANIEL N. MILLER, Jr.

A

THESIS

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Associate Professor of Geology

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Abstract

Mason Inlet, North Carolina is a lagoonal marsh area with warm-temperate water, the salinity ranging from fresh to salt water. Nine collecting stations comprise an ecological gradient across the environment.

Forty-two species of foraminifera are recorded from the inlet, ranging in their affinities from brackish water to open-sea facies. Several extensions of range are recorded, both northward and southward.

Substratum conditions apparently control the distribution of foraminifera within the inlet. Clean, fine sand provided the largest faunal populations. A depauperate assemblage was found in an inorganic, argillaceous substratum. The largest population of arenaceous forms was found at the channel through the offshore bar.

INTRODUCTION

Current interest in the ecology of foraminifera is evidenced by the increasing number of publications on the subject. Previously, ecologic studies conducted along the coasts of North America were concentrated at a few oceanographic stations. Present investigations have somewhat coordinated previous correlation but further study is necessary. Mason Inlet, North Carolina provides one more

control point along the Atlantic coast through which zonations can be correlated.

Shallow water foraminifera, like other marine organisms, have certain essential needs which must be provided by their environment. Previous studies have shown that certain marine conditions determine the foraminiferal assemblages to be found. Opinions differ as to the importance of the individual factors. An investigation conducted at Gaspe Bay along the St. Lawrence River, Canada, by G. M. Dawson (1870) showed that lithologic and textural changes in the substratum strongly influence foraminiferal populations. Arenaceous forms did not flourish where bottom material consisted of clean gravel and coarse sand. Only a few depauperate specimens with coarse grained tests were reported on such a substratum. Salinity variation was marked by the contrasting abundance of specimens of "Miliola." The absence of "Miliola" in estuarine waters was strikingly apparent. Regions which were perpetually flushed with fresh water produced scarce, depauperate populations. Similar conclusions were drawn by Kornfeld (1931) from an examination of littoral foraminifera of the Gulf Coast. Arenaceous forms were more abundant in the shallow water embayments. Calcareous forms predominated in open water. No marked differences in assemblages existed between the open coast population and the population in the bays behind the bars.

In a recent investigation at Barnstable and Cape Cod, Massachusetts, Phleger and Walton (1950) found that the largest foraminiferal populations occurred in high marshes, where "organic production" was at a

maximum. Three foraminiferal subfacies were determined at Barnstable Harbor, which apparently are related to tidal action, the nature and movement of the substratum, and the presence of marsh grass and relative "organic production." At Cape Cod two subfacies were found: a near-shore facies, from a sandy substratum, and an off-shore facies from silty sand and mud. These conditions closely resemble those of the salt marsh at Mason Inlet and the assemblages found in both areas are correlative.

Examination of the bottom sediments of the coast of western Long Island and New York Harbor, by Shupack (1934), showed that slight changes in salinity did not influence the assemblages; neither were the populations influenced by the pollution of New York Harbor. These interpretations seem questionable when one considers that two genera and eight species hardly constitute a normal assemblage.

One investigation, a foraminiferal check list of specimens collected from three stations at Beaufort, North Carolina, has been published by Hadley (1936). His results agree with those of the present study, but no detailed ecological study was included.

Foraminifera of the open ocean (continental shelf region) do not show similar ecologic characteristics. Parker (1948), after an examination of the assemblages from the "Northern Lines" (traverses perpendicular to the Atlantic Coast from New England to Maryland), has concluded that there is no correlation between the type of bottom sediment and the abundance of foraminifera. Four definite faunal zones were found, but no interpretation was attempted due to insufficient

knowledge of the life habits of deeper water foraminifers. Cushman's "Southern Lines" (unpublished) will complete Parker's faunal zonation.

Similar studies in foreign countries have been a subject of biogeologic importance. Detailed examination of the northern Atlantic coasts of the British Isles and Europe have provided important ecologic data in a number of publications. A series of publications by Hada (1936, 1937, 1939), on the Japanese estuaries, has provided foraminiferal check lists which have proved useful in the present study. Foraminiferal ecology has become a major factor in the interpretation of fossil material from marine Cretaceous and Tertiary strata. Only through study of Recent faunal distribution can proper interpretation be made of the past.

Acknowledgments: This project was made possible by a Research Fellowship, and through the facilities of the Department of Geology. Both are gratefully acknowledged. Mr. Sankey L. Blanton, Jr., Southern Methodist University, Dallas, Texas, has given me the advantage of his extensive experience in the area, as well as furnishing equipment and assistance in the field work. His initial interest in the fauna of Mason Inlet brought to our attention the feasibility of the project. In addition, assistance by Miss Ruth Todd, U.S. National Museum, Washington, D. C., has been greatly appreciated. The study has been made under the guidance of Dr. Don L. Frizzell.

LOCALITY DESCRIPTIONS

Description of Mason Inlet, North Carolina

Middle Sound is a segment of the system of bars and lagoons that is typical, in its general features, of most of the North Carolina coast (Figure 1). It includes three inlets, the center of which is Mason Inlet. Three major physiographic features are present: (1) an offshore bar which parallels the coast, (2) a salt marsh, with mud flats and oyster beds, and (3) the shore. Many channels connect the inlets and the interior of the marsh. A dredged Inland Waterway is maintained along the shore, providing the deepest water inside the bar. Small fresh water creeks enter the marsh and provide harbors such as Mason Inlet.

Mason Inlet, the central portion of Middle Sound, is situated 13 miles east of Wilmington, North Carolina, on U.S. Highway 17. It is a salt marsh, approximately 1½ miles long and averaging 1 mile in width, consisting in its upper reaches of the meanders of Page Creek and a shallow elongate bay filled with oyster beds.

The intermediate area between Wilmington and the inlet has a gently rolling surface, sustaining various marsh grasses and reeds in the low lands and tall, straight Southern Pines along the ridges. These low, pine covered ridges, about ten feet high, parallel the existing offshore bars of the coast. S. L. Blanton, Jr. (personal communication), who has studied the bars in detail, regards these ridges as remnants of ancient offshore bars.

The flat land between the highway and the inlet is a fresh water swamp. Small, but deep, water filled depressions are surrounded by a mass of vegetation which sustains an abundance of wild life. Salinity is variable in the upper reaches of Page Creek.

The offshore bar in this locality trends northeasterly, and is the outer limit of Mason Inlet. The bar rises about thirty feet above sea level. It consists of wind blown sand dunes, with thick cross bedded sand showing segregation of the dark minerals into thin stratified bands. Vegetation is sparse and variable, its distribution primarily due to wind action. The seaward side of the bar slopes gently down to a beach approximately one hundred yards wide. The landward side of the bar is irregular.

The area between the Inland Waterway and the offshore bar consists of intertidal mud flats and low islands. These islands are predominantly oyster reefs which support thick growths of rough marsh grasses and reeds causing the area to become a swampy jungle in the late summer. Channels between the islands are sporadic, due to filling of the area by shifting sand. Two main channels connect the break in the offshore bar and the waterway. The major channel extends north from the break in the bar along the landward side, then turns west directly to Mason's dock (Station 3). The depth of the water varies in this channel from a few feet to four fathoms and is not suitable for navigation throughout, except by outboard motorboat. The minor channel winds east from the break in the bar and joins the waterway south of Mason's dock. This channel is variable in width and depth, and navigation is hazardous

except by small boat. Shifting sands have filled in the previously existing channel and it therefore is called the secondary channel by the fishermen who use it.

The shore line of Mason Inlet consists primarily of a low sandy ridge, which rises approximately 15 feet above sea level. Small narrow beaches, 10 to 30 feet in width, extend seaward from the hill in some local areas where erosion is active. The irregular surface of the hill is covered by plant life including; grasses, vines, shrubs, and a variety of large trees. S. L. Blanton, Jr. (personal communication), believes the hill to be the youngest of the ancient offshore bars. Evidence supporting this belief was observed in an investigation of the region by the writer.

The drainage of Middle Sound is variable. Surface water drains through creeks in shallow depressions, and empties into the marsh behind the bar. The major inflow of fresh water into Mason Inlet is from Page Creek. The direction and amount of fresh water penetration into the marsh are functions of seasonal rainfall and channel filling. At the time of sampling (March, 1950), fresh water currents were visible at the surface. These passed east from the mouth of Page Creek to Station 3, then south toward Station 5 along the Inland Waterway. This is the normal trend of the fresh water currents (S. L. Blanton personal communication).

Since the date of sampling, the writer has been advised by Mr. Blanton of recent current trends which have altered the fresh water

passage. Present currents (August, 1950) pass from the mouth of Page Creek toward Station 4, then veer north up the Inland Waterway. This change in the direction of flow apparently is due to channel filling south and east of Station 5.

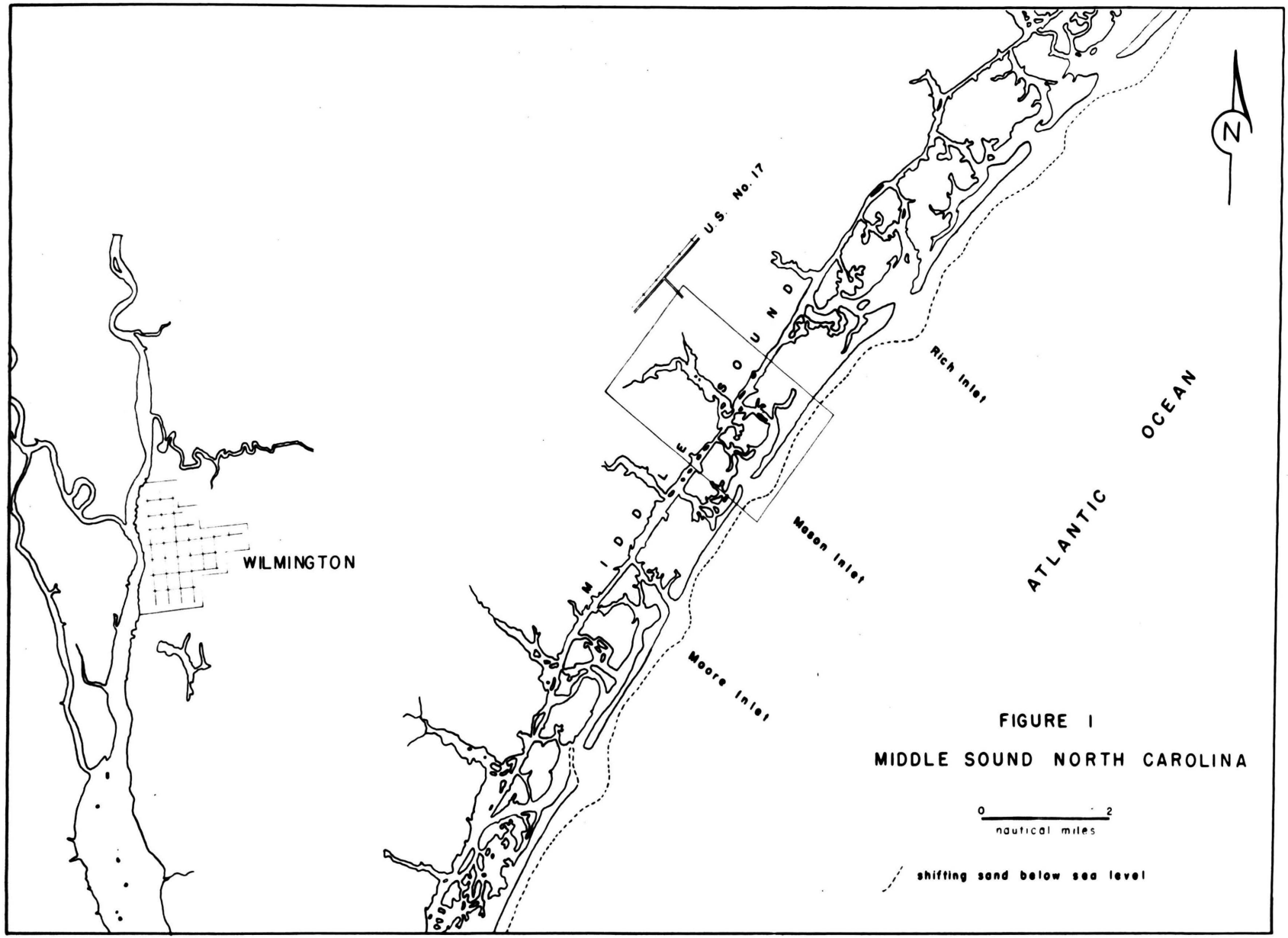


FIGURE 1

MIDDLE SOUND NORTH CAROLINA

Location and Description of Collecting Stations

Sta. 1. Page Creek, 1½ miles upstream from Mason's house, where stream narrows to about 100 ft. Depth: less than 1 fathom. Water: clear, clean. Salinity: low. Substratum: sandy mud; very fine, well sorted, quartz, sand; containing an abundance of brown organic debris, plant remains, large diatoms, ostracodes, micro-gastropods and pelecypods. Oyster beds abundant.

Sta. 2. Page Creek, about 350 yards west of Mason's dock, in front of frame house on north shore. Depth: less than 1 fathom. Water: clear. Salinity: low. Substratum: sandy mud; predominantly oyster shell fragments and very fine, quartz, sand; with an abundance of marine plants and ooze, echinoid spines, ostracodes, gastropods, and pelecypods. Oyster beds abundant.

Sta. 3. Beach sand, from the landward side of the lagoon, in front of house owned by S. L. Blanton. Water: turbid, quiet, influenced only slightly by channel currents. Salinity: subnormal. Substratum: sandy mud; very well sorted, silty sand and shell fragments; containing very little plant remains.

Sta. 4. In the center of the intersection of the Inland Waterway and the major inlet channel on the east side. Depth: 1 to 2 fathoms. Water: clear, clean. Salinity: subnormal. Substratum: clayey sand; firmly packed, gray to black, highly organic, clayey, sand; devoid of visible plant remains and mega fauna. Intra-tidal currents pass through this channel leaving it with a scoured appearance.

Sta. 5. At the intersection of the secondary channel and the Inland Waterway, on the east side, approximately 300 yards southwest of Blanton's house. Depth: 2 to 3 fathoms. Water: turbid but quiet. Salinity: subnormal. Substratum: silty sand; loosely packed, tan, very fine, well sorted, quartz, sand; containing only a small amount of organic debris, and supporting an abundance of molluscan forms and ostracodes.

Sta. 6. Intersection of the major channel and the main tributary outlet, where the channel turns landward from the bar. Depth: 2 to 3 fathoms. Water: turbid, quiet. Salinity: subnormal. Substratum: silty sand; gray, well sorted, silty sand; containing only a minor amount of organic debris and supporting an abundant micro-fauna.

Sta. 7. On the west side of the major channel at the mouth of the creek, approximately 1000 ft. north northeast of the break in the bar. Depth: less than 1 fathom. Water: clear, clean. Salinity: normal. Substratum: sand; clean, tan, very well sorted, very fine, sand; containing only a small amount of organic debris, but sustaining an abundance of micro-organisms including; diatoms, ostracodes, pelecypods, and gastropods.

Sta. 8. Approximately 400 ft. landward from the break in the off-shore bar. Depth: 1 fathom. Water: swift during tidal periods, highly turbid. Salinity: normal. Substratum: sand; firm, gray, fine to medium, quartz, sand; containing no visible plant life and only a minor amount of shell fragments.

Sta. 9. Beach sample from the seaward side of the offshore bar, in front of the Army Lookout Station and approximately 2500 ft. northeast of the break in the bar. Water: turbid. Salinity: normal. Substratum: sand; a normal beach sand; containing an abundance of shell fragments and well sorted, very fine, quartz, sand.

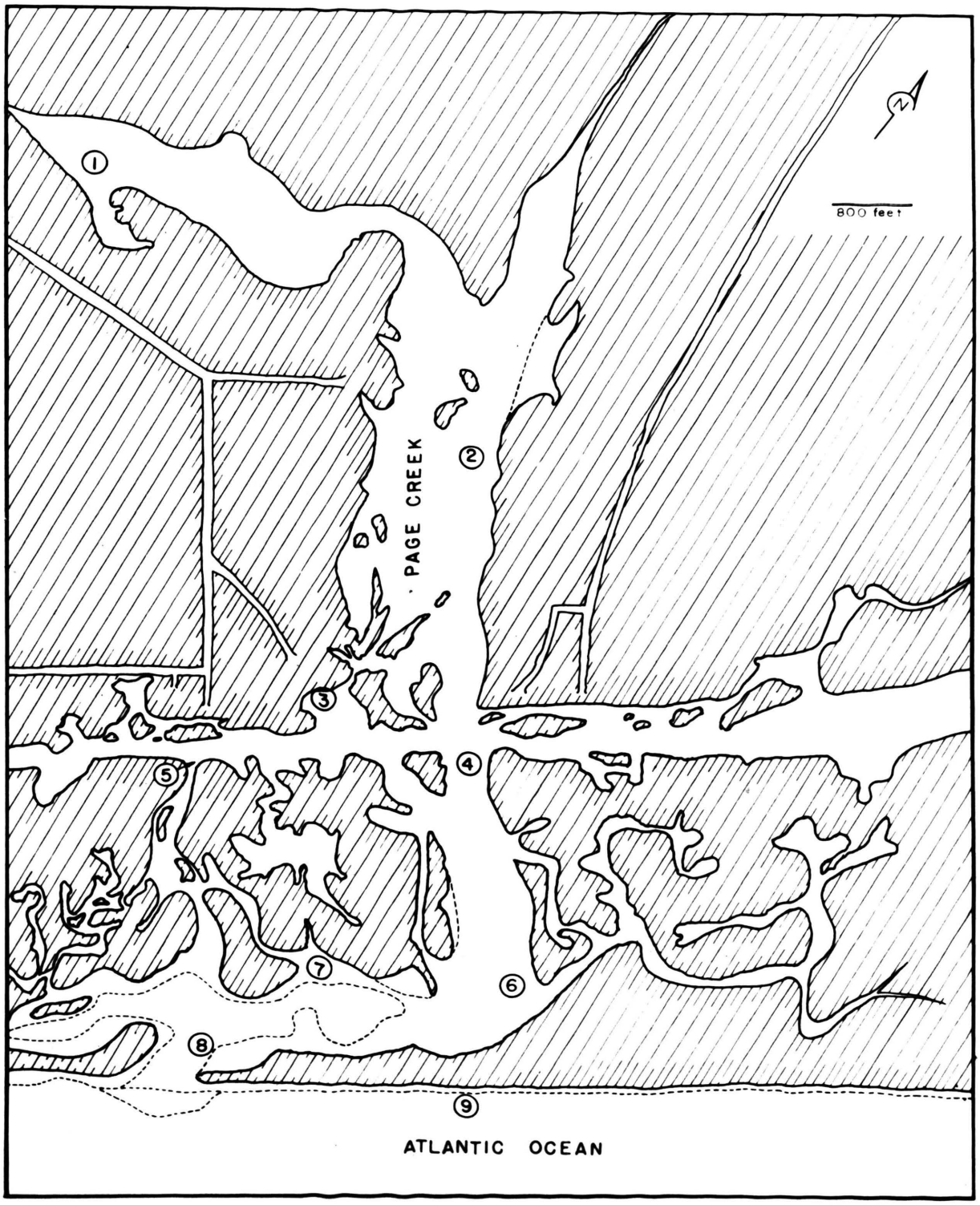


Fig. 2 Detailed map of Mason Inlet North Carolina showing foraminiferal sample locations

ECOLOGY

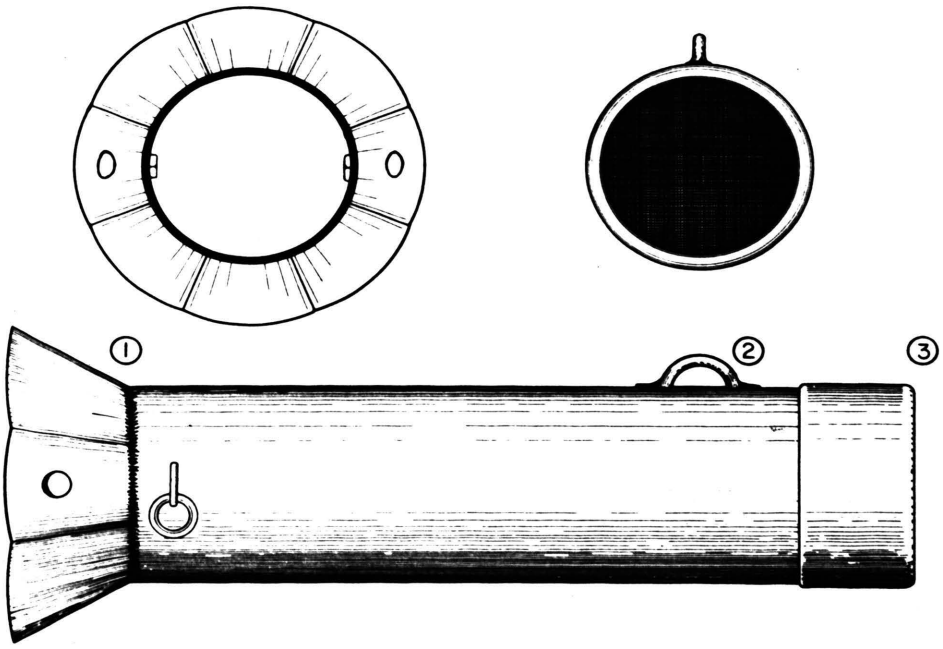
Method of Sampling

The area was sampled at the locations described in the preceding and shown in Figure 2. A dredge (Fig. 3) was used for bottom sampling. Littoral samples were taken at low tide. Salinity was estimated by taste and recorded as low, subnormal, and normal. Chemical analyses of the water were not made because of insufficient time and no information is available on the salinity of this region.

The dredge consists of three parts: (1) a flanged lip, octagonal in shape, made from 8 gauge steel and welded to (2) a pipe 4 inches in diameter, with (3) a butt plate made from a thread protector with a strong screen backing. Total weight of the dredge is 15 pounds and the total cost, when made from scrap material, should not exceed $3.00. Although this dredge was designed independently by the writer, for the purpose of sampling Mason Inlet, it is similar to the dredge previously used by Shupack (1934) in sampling western Long Island Sound and New York Harbor.

Treatment of Samples

A sample of approximately 1000 grams, from each station, was air dried and set aside for sedimentary analysis. The remainder was washed and decanted onto a 200 mesh sieve. As a considerable number of foraminifera tended to float, their retention was required. The sample then was dried and concentrated by carbon tetrachloride flotation. The concentrates were screened, picked and distribution slides of foraminifera prepared.



Front side and end views showing

① Flanged lip welded to pipe

② Safety ring

③ Removable butt-plate

Fig. 3 A diagrammatic sketch of the dredge used at Mason Inlet, North Carolina

Nomenclature of Sedimentary Particles

Through the preceding pages an attempt has been made to use terminology that will be readily understood both by biologists and geologists. Sedimentary analysis, however, requires different definition of some grain size units. Terms such as "mud flat" and "sand" have been used to describe ecological conditions, because they convey the most appropriate meaning. The following descriptions and data, however, are based upon Wentworth's definitions and classification of grain sizes (Wentworth, 1922).

Sedimentary Analysis

The unpicked fraction, 1000 grams, was quartered to a representative sample of 100 grams and sieved on nested screens. Tyler screens, with openings most closely agreeing with Wentworth's classification of grain sizes, were used with the Ro-Tap (mechanical shaker). Table 1 shows the various allocated percentages of the material by weight which was left on the screen after shaking. Care should be exercised in the evaluation of these analyses, on a weight basis, inasmuch as shell fragments constitute nearly 100 per cent of the material coarser than 0.246 mm.. In every case material finer than 0.246 mm. and coarser than 0.124 mm. constitutes a conspicuous modal class. It is the finer material, however, less than 0.124 mm. that is of importance in this study. This material is a very fine sand composed almost entirely of quartz. A microscopic examination of the heavy mineral grains has shown that tourmaline, zircon, and garnet are common.

TABLE 1

Sedimentary analyses of samples from Mason Inlet, showing percentages by weight. (100 gram samples; Tyler screens; separation by Ro-Tap.)

Screen sizes in mm.	+1.98	+0.991	+0.495	+0.246	+0.124	+0.065	-0.065
U.S. Series Equivalent No.	10	18	35	60	120	230	-230
Station							
(1)	0.67	2.27	2.29	16.84	72.57	4.98	0.11
(2)	6.46	6.90	3.25	14.35	59.35	10.02	1.36
(3)	1.72	1.55	3.59	18.60	59.50	11.96	3.04
(4)	0.24	0.11	0.70	19.00	64.88	9.38	5.70
(5)	0.30	0.66	1.34	18.07	77.51	2.05	1.06
(6)	----	0.34	1.37	9.81	72.12	12.35	4.01
(7)	0.39	0.32	0.33	4.94	88.91	4.90	0.21
(8)	0.20	0.23	2.62	19.81	67.73	7.86	1.53
(9)	0.49	0.19	0.40	6.49	88.63	3.37	1.07

Summary of Sedimentary Factors

The accumulated detritus of the lagoon consists of silt, sand, and shell fragments, combinations of which form the "mud-flats" and sandy substratum of the marsh. A sandy facies occurs in the channels. At Station 8, the sand is unconsolidated and free to shift with every tidal change. Station 4, unlike the others, contains 5.7% clay size material which acts as a binder in producing a tough, indurated substratum, free from ooze and soft "muds."

Oyster beds within the inlet are abundant and constitute nearly 100% of the island foundations. Protected pools in and about the oyster beds contain silt and very fine sand. Irregular growth of the oyster beds is directly dependent upon the stability of the existing bar. Seasonal variations disrupt regular deposition throughout the inlet.

The origin of the sediments is diverse. Most of the material is brought in from the mouth of the inlet by wave action; the remainder is derived from the shore. Channel filling, at the break in the offshore bar, is deltaic in structure. The foreset beds, however, face the shore. Accumulated sands have developed a submerged shoal, approximately 250 meters off shore, which parallels the existing bar. The accumulation is visible and has become somewhat enlarged in the past few years. This furnishes the source for the delta-like channel filling.

Other Environmental Factors

Salinity determination was very crude. Accurate determination of salinity control on foraminiferal populations would be desirable, although similar studies have shown that minor changes in salinity do not influence the populations (Shupack, 1934). The temperature of the water was not measured during this investigation, but the water of the lagoon is warm-temperate. The amount of temperature variation between stations is believed to be negligible. Depth of light penetration was not measured. The turbidity of the water at the surface was recorded but no conclusions may be made concerning its importance.

Many environmental factors may influence the foraminifera of Mason Inlet. From available evidence, and in the absence of accurate physical-chemical data necessary to evaluate these factors, some conclusions may be drawn; substratum conditions appear to have the most effect on faunal population. Shifting sands produced the highest arenaceous/calcareous ratio for foraminifera. Compacted, organic, argillaceous sands produced depauperate fauna. Fine, clean sands carried the most abundant populations.

Ecologic Relationships of Foraminifera

Mason Inlet is a brackish water environment, characterized by nearly fresh water in the upper reaches of Page Creek and normal salinity at the bar. Tidal fluctuations are seasonal. At the time of sampling, the tide was approximately 0.84 meters--about the minimum.

A maximum tide of 1.05 meters (U.S. Coast and Geod. Surv. Tide Tables East Coast, 1950) occurred in July, 1950. Seasonal changes affect the area by alternately filling and scouring the channels.

No sharply defined faunal zones have been shown by this study. However, samples collected at stations with similar ecological conditions contain correlative assemblages. Station 8 (at the break in the offshore bar) stands alone in having a predominance of arenaceous forms and lacking miliolid species. Stations 5 and 6 are similar in all respects except for slight differences in the texture of the substratum. Their assemblages are nearly identical. Station 9 (beach sample, open ocean) compares nearly equally well with a sample examined from Kure Beach (south of Wilmington).

Samples (Stas. 1, 2, 5, and 6) containing an abundance of diatoms, gastropods, pelecypods, and other micro-organisms contain large foraminiferal populations. Organic ooze and gelatinous muds did not exist to any great extent where large faunal assemblages were found. Clean, loose, fine sand, uncontaminated by organic debris provided the maximum number of specimens. Littoral samples (Stas. 3 and 9) carried smaller assemblages than the others.

Of the nine stations studied in detail, one (Sta. 4) carries abnormally small foraminifera. The increased current, acting on a compacted substratum of organic, argillaceous sand, provides the conditions under which the population exist. Anaerobic conditions in the organic clay (evidenced by a strong smell of hydrogen sulphide) have

provided a substratum unsuited to normal growth. Many of the specimens contained pyrite grains which are visible in the transparent chambers. These contrast with specimens collected from other stations, that are for the most part of normal size and devoid of pyrite.

Specimens of Triloculina brevidentata collected from Stations 1, 3, 4, 5, 6, and 7 are characteristically small. These diminutive specimens range from 0.40 to 0.43 mm.. Normal specimens, reported from other localities, typically range from 1.10 to 1.25 mm. Whether this is complete depauperization of the population or an undescribed variety is not known. Similarly, specimens of Globigerinoides rubra were found (Stas. 1, 2, 4, 5, 6, and 7) less than 0.20 mm. in diameter.

Reworked Foraminifera

Specimens of Gümbelina have been found. All are white to light tan and do not show chamber filling. The surface of the tests are worn, but only to a minor extent. There is a slight discoloration in some cases which is not the typical discoloration of fossil material found (Eponides frigida (Cushman) var. calida Cushman and Cole). Many of the tests have final chambers which are translucent with perfectly defined, smooth apertures. Striated forms show more wear than the smooth varieties. The majority of these specimens were collected from Station 1 (a nearly fresh water sample in semi-isolation from the marine waters).

The genus Gümbelina is typically known from Cretaceous fossil material of the Gulf Coast. Contamination of this sample with Cretaceous

TABLE 2. ECOLOGIC DATA FROM SAMPLE LOCATIONS

Station	Depth in fathoms	Nature of the water	Salinity	Substratum		Micro-fauna other than foraminifera	Number of foraminiferal species	Flora	Remarks
				Description	% finer than 0.124 mm.				
1	0-1	clear, clean	low	Very fine sandy silt with abundant organic remains	5.09	Large diatoms, ostracods, micro-gastropods, pelecypods	21	Abundant, brown, organic, debris; plant remains	Taken from deltaic deposit of fresh water creek, in hole between oyster beds
2	0-1	clear	low	Fine, sandy, mud with abundant oyster shell fragments	11.38	Echinoid spines, ostracods, gastropods, pelecypods	18	Abundant plant remains ooze, algae	Taken in sandy channel between oyster beds
3	beach	turbid, quiet	subnormal	Sandy, silty, mud with abundant shell fragments	15.00	none	13	Very little plant remains and algae	Littoral beach sand, influenced at high tide by wave action
4	1-2	clear, clean	subnormal	Organic, clayey, sand	15.08	Fragments of pelecypods, and gastropods	22	none	Scoured channel due to intertidal currents, faunas depauperate and dark colored
5	2-3	turbid, quiet	subnormal	Silty sand	3.11	Abundant ostracods, pelecypods, gastropods, echinoids, diatoms	37	Very little plant remains	This station probably influenced by the deep channel of the Inland Waterway
6	2-3	turbid, quiet	subnormal	Silty sand	16.36	Large diatoms, ostracods, gastropods, pelecypods, echinoid spines, sponges	35	Very little plant remains	Basin, influenced by 3 currents; 2 are fresh water, 1 saline
7	0-1	clear, clean	normal	Very fine sand	5.11	Diatoms, ostracods, pelecypods, gastropods	29	Very little plant remains	Taken adjacent to transgressing sandy shoal
8	1-2	turbid, swift	normal	Fine to medium sand	9.33	none	17	none	Taken from channel at the break in the off-shore bar; turbulent during tidal periods
9	beach	violent wave action	normal	Fine sand with abundant shell fragments	4.44	none	13	none	Taken from unconsolidated sandy beach influenced by violent wave action

material is a possibility; however, the abundance, uniform characteristics and lack of chamber filling suggests Recent fauna. No Cretaceous outcrops occur near this region and the substratum overlies older Recent sediments.

Some specimens of Cibicides concentrica and Globigerinoides rubra also show discoloration and wear, similar to Gümbelina. Both C. concentrica and G. rubra occur as normal living foraminifera. Comparison of the worn tests of Gümbelina, G. rubra, and C. concentrica shows marked similarity.

The occurrence of unquestionably reworked fossils is evident. Eponides frigida var. calida occurs in the inlet in fossil form. It is strongly discolored, greenish tan, and shows definite abrasion of the test. There is very little comparison between the character of these tests and those of Gümbelina.

Extension of Ranges

The geographic range of "Ammobaculites" cassis (Parker), previously recorded, by Phleger and Walton, as a cold water species with a southernmost occurrence at Cape Cod, Massachusetts, is here extended 700 miles south to Mason Inlet.

Previously, Hadley recorded Spiroloculina planulata (Lamarck) at Beaufort, North Carolina. The presence of the species at Mason Inlet verifies Hadley's findings and offers an extension of geographical range to the shallow water of the western Atlantic Ocean.

Nine specimens of Lagena aff. laevigata (Reuss) have been found at Station 4. This species has not previously been recorded from the western Atlantic Ocean. An extension of range to Mason Inlet is suggested but not proved.

Numerous specimens of Buliminella elegantissima (d'Orbigny) were found at Stations 4 and 6. Previously, the species was recorded from the coast of Florida and the New England coast. Its presence in the shallow waters of Mason Inlet provides one more location, nearly half-way between, where it was found in abundance.

A northern extension of the geographic range is also placed on record for Planulina caribaea Cushman. Two specimens were found at Mason Inlet.

A single specimen of Planorbulina mediterranensis d'Orbigny was found. Previously specimens had been found as far north as Florida. The occurrence of the species at Mason Inlet extends the range approximately 300 miles north.

TABLE 3. FORAMINIFERAL CHECK LIST

	Station:	1	2	3	4	5	6	7	8	9
1.	Reophax sp.				R		R		R	
2.	Haplophragmoides? sp.						R		R	R
3.	"Ammobaculites" cassis (Parker)			R		R			VA	
4.	Textularia cf. parvula Cushman				MC		MC		R	
5.	Miliammina fusca (Brady)								MC	
6.	Quinqueloculina lamarckiana d'Orbigny	C				R		R		
7.	Quinqueloculina poeyana d'Orbigny	A			R	MC	A	R		
8.	Quinqueloculina cf. seminulum (Linné)	R	C		R	A		A		A
9.	Quinqueloculina seminulum (Linné) var. jugosa Cushman	C	MC	R	MC	VA	C	C		C
10.	Miliolinella sp.							R		
11.	Spiroloculina planulata (Lamarck)					MC	R			
12.	Triloculina cf. brevidentata Cushman	MC		R	C	R	R	R		
13.	Cornuspira? sp.	R			R			R		
14.	Planispirina auriculata Egger	R			R					
15.	Trochammina inflata (Montagu)		R	C		C	C		R	
16.	Lagena aff. laevigata (Reuss)				MC					
17.	Globulina cf. gibba d'Orbigny					R	R			
18.	Sigmomorphina? aff. williamsoni (Terquem)						MC			
19.	Nonion sp.	R	C	C	A	R	R	R	A	R
20.	Nonionella aff. auricula Heron-Allen & Earland	R				MC		MC		C
21.	Elphidium gunteri Cole var. galvestonensis Kornfeld								C	
22.	Elphidium incertum (Williamson)	C	C	A	R					
23.	Elphidium aff. incertum (Williamson) var. mexicanum Kornfeld	C	R	R	R	MC	A	R		
24.	Elphidium sp.		MC			R				
25.	Elphidium n. sp.								R	
26.	Buliminella elegantissima (d'Orbigny)				A		MC			
27.	Bulimina sp.				R					
28.	Bolivina subaenariensis Cushman	MC					MC			R
29.	Reusella sp.					R	R			
30.	Uvigerina sp.	R				R	R			
31.	Discorbis sp.				MC	R				
32.	Eponides aff. wrightii (H. B. Brady)		R					R	R	
33.	Poroeponides repanda (Fichtel & Moll)					C	C	MC		MC
34.	"Rotalia" cf. beccarii (Linné)	MC	R	MC	A	C	A	C	MC	R
35.	Globigerinoides cf. rubra d'Orbigny	MC	R		MC	C	VA	C		
36.	Globigerinella sp.				A					
37.	Planulina caribaea Cushman							R		
38.	Cibicides cf. concentrica (Cushman)	R				MC	R	MC		C
39.	Cibicides floridanus (Cushman)	R								R
40.	Cibicides cf. refulgens Montfort		R			R	R			
41.	?Dyocibicides biserialis Cushman & Valentine							R		
42.	Planorbulina mediterranensis d'Orbigny						R			

Frequency (number of specimens): R, 1-3; MC, 4-10; C, 11-20; A, 21-35; VA, over 35.

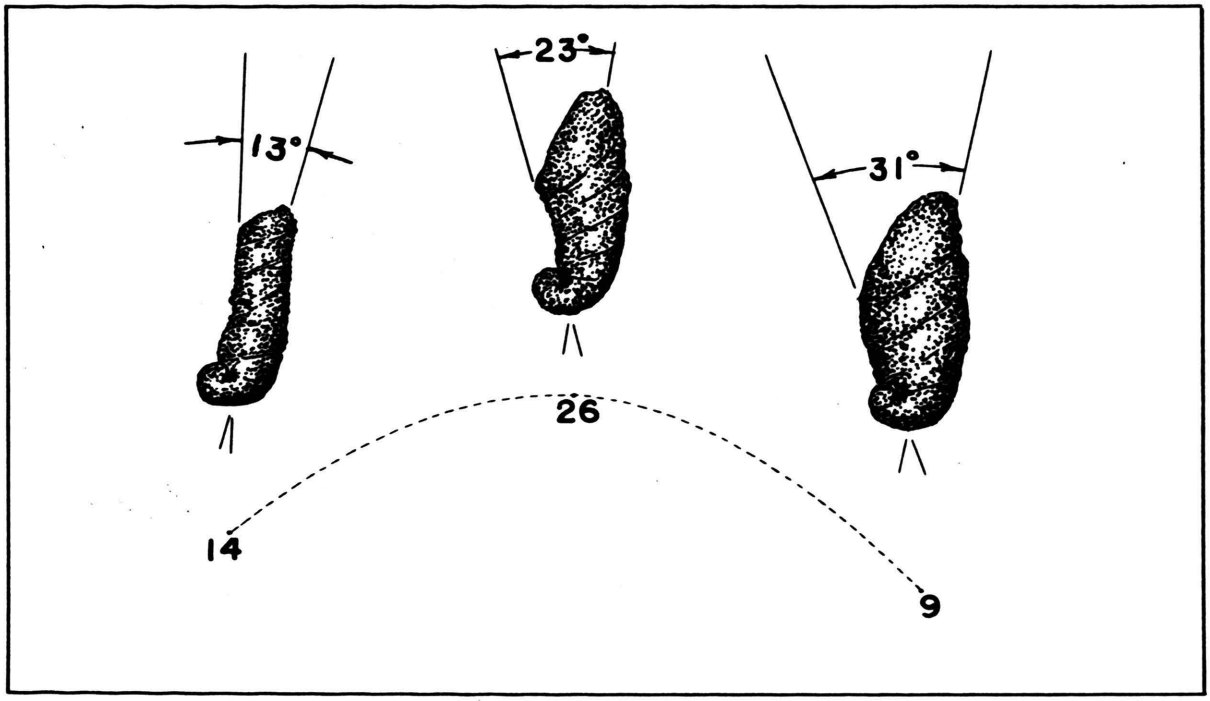


Fig. 4 Illustration of the variation in the shape of "Ammobaculites" cassis Parker. Figures indicate the number of specimens at the end points and mode of the plotted curve.

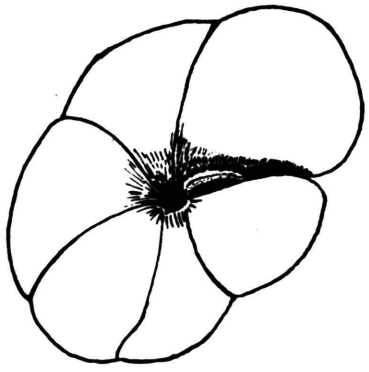


Fig. 5 An oblique ventral view of Trochammina inflata (Montagu) illustrating the aperture and apertural lip.

SYSTEMATIC DESCRIPTIONS

An attempt has been made to condense the synonymic references. Those references immediately preceded by an asterisk (*) have been seen by the writer. Other references were obtained from available publications, including Ellis and Messina (1940).

Interrogation marks (?) have been used with specific and generic names to abbreviate explanations. A question mark preceding a species indicates that entire identification is doubtful. A question mark following a genus indicates that only the genus is doubtful. Quotation marks ("Ammobaculites") indicate that a generic change is anticipated.

An abbreviated reference guide has been used wherever possible. Volume, part, and page (or foreign language equivalents) have been indicated in the form 14(1):24-31(vol. 14, part 1, pp. 24 to 31). Bulletins and Special Publications have been abbreviated to Bull., 104(6):73 or Sp. Pub., 12(2):21 (Bulletin 104 or Special Publication 12). Other abbreviations follow conventional standards.

Some new terms have been introduced for special morphological features. "Interprocess pits", refers to the circular or near circular depressions between the retral processes in the sutures of the genus Elphidium. Most of these terms are believed to be self explanatory.

The following foraminifera are arranged in accord with Cushman's classification of the families and genera. Species are placed in alphabetical order.

FAMILY REOPHACIDAE

Genus Reophax Montfort, 1808

Conch. Syst., 1:331. Genotype: Reophax scorpiurus Montfort.

Reophax sp.

Pl. 1, fig. 6

Description: Test very small (length, 0.34 to 0.39 mm.), free, arenaceous, consisting of about 7 elongate uniserial chambers, increasing very gradually in size. Chambers slightly inflated, circular in cross-section; height of chamber approximately equal to diameter. Sutures distinct in last chambers, evenly curved, slightly oblique, depressed. Septal face evenly rounded. Aperture small, simple, terminal, circular, not produced but with fine rounded rim. Test material fine, well sorted, consisting of quartz sand with occasional darker grains. Color unevenly light to dark tannish gray.

Collecting Stations: Stas. 4, 6, and 8 (rare).

FAMILY LITUOLIDAE

Genus Haplophragmoides Cushman, 1910

U.S. Nat. Mus., Bull., 71(1):99. Genotype: Nonionina canariensis d'Orbigny.

Haplophragmoides? sp.

Pl. 1, fig. 5

Description: Test small (greater diameter, 0.40 to 0.42 mm.), free, arenaceous, depressed trochoid, early whorls indistinct; 5 to 7 chambers in last whorl (typically 6). Chambers of last whorl moderately

well defined by arcuate peripheral outlines. Sutures indistinct. Wall entire; composed predominantly of poorly sorted quartz grains, crystals of darker minerals conspicuous. Aperture indistinct, basal, not enclosed by septal face. Color light tan.

Collecting Stations: Stas. 6, 8, and 9 (rare).

Remarks: All of the specimens showed chemical decomposition of the cement within a short time. In nearly every case the test collapsed several days after mounting.

Genus Ammobaculites Cushman, 1910

U.S. Nat. Mus., Bull., 71(1):99. Genotype: Spirolina agglutinans d'Orbigny.

"Ammobaculites" cassis (Parker)

Pl. 1, fig. 1, 2, 3; text fig. 4

Lituola cassis Parker, 1870, *in Dawson, Canadian Nat., n.s., 5:176, fig. 3.

Ammobaculites cassis (Parker). Cushman and McCulloch, 1939, 6:83 (Synonymy).--*Cushman, 1944, Cushman Lab. Foram. Research, Sp. Pub., 12:12, pl. 1, figs. 23-25.--*Phleger & Walton, 1950, Am. Jour. Sci., 248(4):274, pl. 1, figs. 11-14.

Type Locality: Gaspe Bay, Gulf of the St. Lawrence River, Canada.

Description: Test of medium size (length, 0.47 to 1.20 mm.), arenaceous, elongate, consisting of a very small initial coil followed by an arcuate series of uniserial chambers. Initial coil trochoid,

highly compressed, 1 to 1½ whorls; subsequent portion uniserial, slightly arched, consisting of four or five chambers that increase gradually in width; width of uniserial chambers extremely variable; width/length ratios, 25% to 70% (typically about 31%). Chambers of uniserial part low (width/height ratios about 48%), inclined downward at angle of 12 to 40 degrees (typically 35 degrees), slightly inflated; height of last chamber about one and one third times height of penultimate chamber, septal face arched. Sutures indistinct in initial coil; in later part narrow, impressed, in some cases indistinct. Wall entire; composed of medium to fine, subrounded grains, moderately well sorted; predominantly quartz, with occasional larger grains and crystals of tourmaline, garnet, and zircon; color buff, included crystals conspicuous. Aperture simple, circular, large, terminal, situated near peripheral margin, slightly produced.

Collecting Stations: Stas. 8 (very abundant), 3 and 5 (rare).

Geographic Range: Ammobaculites cassis (Parker) has been recorded (Cushman, 1920, 1944; Phleger & Walton, 1950) as a cold water ("Arctic") species. It has been reported as far south as Cape Cod, Massachusetts. An extension of the range southward to Mason Inlet, North Carolina is now placed on record, the species having been found in abundance at one station and rare at two others.

Remarks: Identification of Ammobaculites cassis (Parker) in Mason Inlet, extends the range of the species approximately 700 miles south. The temperature of the water at Mason Inlet is not cold, in contrast to previous localities where the species has been found.

See pg. 11 for ecological conditions at Station 8 where it was found in abundance.

FAMILY TEXTULARIDAE

Genus Textularia Defrance, 1824

Dict. Sci. Nat., 32:177. Genotype: Textularia sagittula Defrance.

Textularia sp. cf. T. parvula Cushman, 1922

Pl. 1, fig. 4

?Textularia parvula *Cushman, 1922, U.S. Nat. Mus., Bull., 104(3):11, pl. 6, figs. 1,2.

Type Locality of Textularia parvula: Albatross Station H-79 at 821 fathoms, in the eastern part of the Caribbean Sea.

Description: Test of medium size (length 0.24 to 0.41 mm.), free, arenaceous, elongate, with tiny initial coil followed by a series of biserial chambers. Chambers of initial coil extremely small, indistinct, approximately 1 whorl; chambers in biserial portion distinct, elliptical in cross-section, 6 to 8 tiers; growth gradual and regular. Sutures impressed, narrow, distinct in biserial portion. Aperture simple, of medium size, curved, median; consisting of an arch at base of septal face. Test material predominantly well sorted, very fine, quartz sand grains, with occasional conspicuous crystals of tourmaline. Color light tan to buff.

Collecting Stations: Stas. 4, 6 (moderately common), and 8 (rare).

Geographic Range: Textularia parvula has been recorded by Cushman from several Albatross Stations in the Caribbean Sea. Most occurrences were at depths greater than 60 meters.

FAMILY SILICINIDAE

Genus Miliammina Heron-Allen and Earland, 1930

Journ. Roy. Micr. Soc., p. 140. Genotype: Miliammina oblonga (Montagu) var. arenacea Chapman.

Miliammina fusca (Brady), 1870

Pl. 1, fig. 10

Quinqueloculina agglutinans d'Orbigny. H. B. Brady, 1865, Nat. Hist. Trans. Northumberland and Durham, 1:87,95 (misidentification).

Quinqueloculina fusca H. B. Brady, 1870, Brady, Ann. Mag. Nat. Hist., Ser. 4, 6:286, pl. 11, fig. 2.---*Cushman, 1929, U.S. Nat. Mus., Bull., 104(6):23, pl. 1, figs. 4a-c.

Miliolina fusca (Brady). Balkwill and Millett, 1884, Journ. Micr., 28:325.

Miliammina fusca (Brady). *Hada, 1936, The Zool. Mag., 48(8,9,10):852; *1937, 49(10):345 (Japanese).---*Phleger & Walton, 1950, Am. Jour. Sci., 248(4):280, pl. 1, figs. 19a,b.

Type Locality: Not designated (see range, below).

Description: Test of medium size (length, 0.39 to 0.46 mm.), free, arenaceous, elliptical, with rounded periphery, quinqueloculine; chambers arcuate, circular in cross-section; maximum width/length ratios, 46% to 48% (typically 48%). Sutures distinct, narrow, im-

pressed. Wall entire, composed of fine to medium, moderately well sorted sand grains; predominantly quartz, with occasional crystals of tourmaline. Aperture large, simple, circular, terminal. Color light to dark tan.

Collecting Stations: Sta.. 8 (moderately common).

Geographic Range: This species is recorded as common from regions of brackish water along the coast of Great Britain, and the British Isles (Cushman 1929). It has also been reported by Cushman from Casco Bay, Maine, and by Phleger and Walton from Cape Cod, Massachusetts. The brackish water of several Japanese estuaries has yielded typical specimens (Hada 1936, 1937).

FAMILY MILIOLIDAE

Genus Quinqueloculina d'Orbigny, 1826

Ann. Sci. Nat., 7:301. Genotype: Serpula seminulum Linne.

Quinqueloculina lamarckiana d'Orbigny, 1839

Pl. 1, fig. 8

Quinqueloculina lamarckiana d'Orbigny, 1839, in de la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 189, pl. 11, figs. 14,15.
--Cushman, 1921, U.S. Nat. Mus., Proc., 59:65, pl. 15, figs. 13,14;
*1929, U.S. Nat. Mus., Bull., 104(6):26, pl. 2, figs. 6a-c.
--*Hadley, 1936, Elisha Mitchell Sci. Soc., Jour., 52:35 (check list only).

Quinqueloculina auberiana d'Orbigny, 1839, in de la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 193, pl. 12, figs. 1-3.

Quinqueloculina cuvieriana H. B. Brady, 1884, Rep. Voy. Challenger, Zoology, 9:162, pl. 5, figs. 12a-c.

Type Locality: Not designated (see range, below).

Description: Test of medium size (length, 0.49 to 0.58 mm.), free, calcareous-imperforate, quinqueloculine; maximum width/length ratios, 40% to 51% (typically 40%). Lateral axis through final chamber rotated about 120 degrees from axis of preceding chamber. Chambers inflated, arcuate, rounded in cross-section, distinct; with thin, impressed sutures. Aperture large, terminal, elliptical; with a single, large, medium-sized tooth extending nearly half way across opening. Color white.

Collecting Stations: Stas. 1, 6 (common), 5, and 7 (rare).

Geographic Range: This species has been recorded from shore sands of Cuba, Jamaica, and Martinique by d'Orbigny. It has also been recorded from the Indian Ocean and the British Isles (as Quinqueloculina auberiana). Hadley reported the species as common at Beaufort, North Carolina.

Quinqueloculina poeyana d'Orbigny, 1839

Pl. 2, fig. 2

Quinqueloculina poeyana d'Orbigny, 1839, in de la Sagra, Hist. Fis. Pol. Nat. Cuba, "Foraminiferes", p. 191, pl. 11, figs. 25-27.
--Cushman, 1921, U.S. Nat. Mus., Proc., 59:67, pl. 16, figs. 7,8;
*1929, U.S. Nat. Mus., Bull., 104(4):31, pl. 5, figs. 2a-c.
--*Hadley, 1936, Elisha Mitchell Sci. Soc., Jour., 52:35,37 (check list only).

Type Locality: Shore sands of Cuba.

Description: Test of medium size (length, 0.62 to 0.67 mm.), free, calcareous-imperforate, quinqueloculine; maximum width/length ratios, 45% to 46% (typically 46%). Chambers elongate, arcuate; nearly circular in cross-section; with distinct, narrow longitudinal costae. Sutures distinct, narrow, curved, impressed. Aperture simple, large, nearly circular, terminal; slightly extended, with smoothly rounded lip and narrow, simple tooth; tooth usually slightly extended above lip. Color white to light tan.

Collecting Stations: Stas. 1, 6 (abundant), 5 (moderately common), 4, and 7 (rare).

Geographic Range: Quinqueloculina poeyana has been recorded from several stations in the West Indies, and has been reported as common near Cuba, Puerto Rico, Jamaica, and the Tortugas.

Quinqueloculina sp. cf. Q. seminulum (Linne)

Pl. 2, fig. 1

?Serpula seminulum Linne, 1767, Syst. Nat. ed. 12, p. 1264.

?Quinqueloculina seminulum (Linne), d'Orbigny, 1826, Ann. Sci. Nat., 7:303.--*Cushman, 1929, U.S. Nat. Mus., Bull., 104(6):24, pl. 2, figs. 1,2.--*Kornfeld, 1931, Stanford Univ., Geol. Dept., Contr., 1(3).--*Hadley, 1936, Elisha Mitchell Sci. Soc., Jour., 52:35. --*Hada, 1936, The Zool. Mag., 48(8,9,10):858; 1937, Ibid., 49(10):345.--*Parker, 1948, Mus. Comp. Zool., Bull., 100(2):214, 241.--*Phleger & Walton, 1950, Am. Jour. Sci., 248(4):285, pl. 1, fig. 20.

Type Locality of Quinqueloculina seminulum: Rimini, Italy.

Description: Test large (length, 0.70 to 0.82 mm.), free, calcareous-imperforate, quinqueloculine; maximum width/length ratios, 42% to 49% (typically 46%). Chambers arcuate, inflated, smooth, oval in cross-section. Sutures thin, impressed. Aperture large, terminal, nearly circular; with a large, single tooth extending half way across opening. Color white.

Collecting Stations: Stas. 1, 4 (rare), 2 (common), 5, 7, and 9 (abundant).

Geographical Range: This species is common at many localities in the western Atlantic Ocean. Cushman has recorded Quinqueloculina seminulum as most abundant in the shallow water typical of the northeastern coast of America and Europe. The species is also common in shallow, brackish estuaries of Japan (Hada 1936, 1937). It is not a typical warm water species, as evidenced by its rare occurrence in the Gulf of Mexico near Texas and Louisiana (Kornfeld 1931).

Stratigraphic Range: This species has been recorded from the Pliocene of Italy.

Quinqueloculina seminulum (Linne) var. jugosa Cushman, 1944

Pl. 2, fig. 5

Quinqueloculina seminulum (Linne) var. jugosa *Cushman, 1944, Cushman Lab. Foram. Research, Sp. Pub., 12:13-14, pl. 2, fig. 15.--*Parker,

1948, Mus. Comp. Zool., Bull., 100(2):222, pl. 1, fig. 5 (check list and figure only).

Type Locality: Thirteen fathoms, 1½ miles north of Mnemsha Bight, Vineyard Sound, Massachusetts.

Description: Test of medium size (length, 0.51 to 0.60 mm.), free, calcareous-imperforate, ellipsoidal, quinqueloculine; maximum width/length ratios, 59% to 61% (typically 60%). Chambers arcuate, inflated, with strong, irregular, longitudinal ribs; ribs narrow, with slightly raised ridges. Sutures distinct, impressed. Aperture large, terminal, elliptical, with medium-sized bifurcate tooth. Color white.

Collecting Stations: Common at Stas. 1, 6, 7, and 9; rare at Sta. 3; moderately common at Stas. 2 and 4; and very abundant at Sta. 5.

Geographic Range: This variety has been recorded from shallow waters of the Atlantic Ocean south of Cape Cod. It was found in abundance off the end of the pier at Kure Beach, North Carolina.

Genus Miliolinella Wiesner, 1931

Deutsche Südpolar-Exped., 20(Zool.):65. Genotype: Quinqueloculina lamellidens Reuss.

Miliolinella? sp.

Pl. 1, fig. 11

Description: Test of medium size (length, 0.45 mm.), free, calcareous-perforate, quinqueloculine; nearly elliptical in outline,

maximum width/length ratio 62%. Chambers inflated, smooth, arcuate, finely perforate; growth regular, distinct. Sutures narrow, slightly impressed. Aperture simple, large, terminal; slightly produced with single, wide tooth extending across the entire width of the final chamber opening. Apertural opening narrow, curved with a smoothly rounded lip. Color translucent to white.

Collecting Stations: Sta. 7 (rare).

Remarks: This description is based on a single well preserved specimen.

Genus Spiroloculina d'Orbigny, 1826

Ann. Sci. Nat., 7:298. Genotype: Spiroloculina depressa d'Orbigny.

Spiroloculina planulata (Lamarck)

Pl. 1, fig. 9

Miliolites planulata Lamarck, 1804, Ann. Mus., 5(4):352.

Spiroloculina planulata (Lamarck). McDonald, 1857, Ann. Mag. Nat. Hist., ser. 2, 20:153, pl. 6, fig. 28.--Heron-Allen and Earland, 1922, British Antarctic Exped., Zool., 6:63; 1926, Trans. Zool. Soc. London, 22(1):68, (check list only).--*Cushman, 1929, U.S. Nat. Mus., Bull., 104(6):41-42, pl. 8, figs. 2-5.--*Hadley, 1936, Elisha Mitchell Sci. Soc., Jour., 52:35-37.--*Hada, 1934(?), p. 32, in check list, (reprint lacking date and title; Japanese, with English summary).

Type Locality: Louvres près Paris, France.

Description: Test of medium to large size (length, 0.62 to 0.70 mm.), free, calcareous, irregularly elliptical, of angular, arcuate chambers with convex periphery; maximum width/length ratios, 54% to 61% (typically 60%). Chambers nearly square in cross-section, edges thickened; 7 to 8 chambers in the adult, initial chambers depressed between larger and wider final chambers, growth distinct, regular. Sutures narrow, incised, curved lines. Aperture large, terminal; nearly circular; with thick, even rim, and a single large tooth. Chambers white with translucent filling along the sutures.

Collecting Stations: Stas. 5 (moderately common) and 6 (rare).

Geographic Range: This species is recorded as common from several stations near the European coast and the British Isles. It has been recorded as rare at one station near Beaufort, North Carolina (Hadley 1936).

Remarks: References to this species in the western Atlantic Ocean are few. The presence of Spiroloculina planulata at Beaufort and Mason Inlet, North Carolina offers evidence of its range as a species of warm-temperate water in the western Atlantic Ocean.

Genus Triloculina d'Orbigny, 1826

Ann. Sci. Nat., 1:299. Genotype: Miliola trigonula Lamarck.

Triloculina sp. cf. T. brevidentata Cushman, 1944

Pl. 1, fig. 7

?Triloculina brevidentata *Cushman, 1944, Cushman Lab. Foram. Research, Sp. Pub., 12:16, pl. 2, fig. 25.

Type Locality of Triloculina brevidentata: Coffins Beach, Annisquam, Massachusetts.

Description: Test of medium size (length, 0.40 to 0.43 mm.), free, calcareous, smooth, triloculine; maximum width/length ratios, 75% to 76% (typically 75%). Chambers inflated, evenly rounded, distinct; slightly narrower at the apertural end. Sutures depressed, narrow, distinct. Aperture large, terminal, nearly circular, prominent; single, short, wide, bifid tooth prominent; tilted up, away from the center of the aperture. Color white, luster vitreous.

Collecting Stations: Sta. 1 (moderately common), 4 (common), and Stas. 3, 5, 6, and 7 (rare).

Geographic Range: This species has been recorded by Cushman as common at the type locality and along the coast of Massachusetts and Maine.

Remarks: If this species is Triloculina brevidentata, it is greatly reduced in size. The normal lengths of the type specimens are from 1.10 to 1.25 mm..

FAMILY OPHTHALMIDIIDAE

Genus Cornuspira Schultze, 1854

Organismus Polythal., p. 40. Genotype: Cornuspira planorbis Schultze.

Cornuspira? sp.

Pl. 2, fig. 4

Description: Test small (greater diameter, 0.24 mm.), calcareous-

imperforate, circular, flattened, planispiral; thickness/greater diameter ratio, 12%. Approximately 3 whorls in the adult, initial coil indistinct. Whorls regular, visible dorsally, overlain by nodes of test material ventrally. Nodes small, well-rounded, irregularly spaced. Periphery unevenly rounded, slightly flattened dorsally. Suture narrow, irregularly limbate, depressed along final whorl; sculptured with regular, small, oval depressions, marginal in initial coil, absent in last 1/3 of final whorl. Surface wrinkled in last 1/3 of final whorl. Aperture large, oval, terminal; includes the entire end of chamber. Color white.

Collecting Stations: Stas. 1, 4, and 7 (rare).

Remarks: Three specimens were obtained, all of which have similar characteristics but none of which is entire.

Genus Planispirina Sequenza, 1880

Atti R. Accad. Lincei, ser. 3, 6:310. Genotype: Planispirina communis Seguenza.

Planispirina auriculata Egger, 1893

Pl. 2, fig. 3

Planispirina auriculata Egger, 1893, Abh. Kön. bay. Akad. Wiss. München, Cl. II, 18:245, pl. 3, figs. 13-15.--Heron-Allen and Earland, 1915, Trans. Zool. Soc. London, 20:590, pl. 46, figs. 3-7.--*Cushman, 1929, U.S. Nat. Mus., Bull., 104(6):93-94, pl. 22, fig. 3; 1932, Ibid. 161(1):72, pl. 16, figs. 6a-c.

Type Locality: Indo-Pacific

Description: Test small (length, 0.36 mm.), free, calcareous-imperforate, bluntly elliptical and flattened, with 3 chambers visible on one side and 1 on the other. Final chambers are milioline; earlier chambers form an elongate flattened coil, visible in transmitted light; maximum width/length ratio 41%. Apertural end bluntly rounded, flattened. Sutures distinct, curved, fine lines, slightly impressed. Aperture large, hemispherical, simple; includes entire side of final chamber that extends above penultimate chamber. Test material curved about the sides and top of aperture, thickened. Color translucent to white.

Collecting Stations: Stas. 1 and 4 (rare).

Geographical Range: This species has previously been recorded from the Indo-Pacific. Its rare occurrence in the Tortugas indicates this to be a warm water species. Several specimens have been found as far north as Beaufort, North Carolina (Cushman 1929).

FAMILY TROCHAMMINIDAE

Genus Trochammina Parker and Jones, 1859

Ann. Mag. Nat. Hist., ser. 3, 4:347. Genotype: Nautilus inflatus Montagu.

Trochammina inflata (Montagu)

Pl. 2, fig. 9

Nautilus inflatus Montagu, 1808, Test. Brit., Supple., p. 81, pl. 18, fig. 3.

Rotalina inflata (Montagu). Williamson, 1858, Rec. Foram. Great Britain, p. 50, pl. 4, figs. 93,94.

Trochammina inflata (Montagu). *Carpenter, Parker, and Jones, 1862, Int. Foram., p. 141, pl. 11, fig. 5.--Heron-Allen and Earland, 1909, Journ. Roy. Micr. Soc., p. 324; 1913, Proc. Roy. Irish Acad., 31(64):52.---*Cushman, 1920, U.S. Nat. Mus., Bull., 104(2):73. --*Phleger & Walton, 1950, Am. Jour. Sci., 248(4):280, pl. 2, figs. 1-3.

Type Locality: Unknown

Description: Test of medium size (greater diameter, 0.42 to 0.45 mm.), free, arenaceous, depressed trochoid. Typically $2\frac{1}{2}$ whorls in the adult, consisting of an initial coil of depressed chambers and a final whorl of 6 large, well-rounded chambers inflated ventrally. Chambers distinct with peripheral margin well rounded. Umbilicus deep, irregular. Sutures distinct, impressed. Septal face rounded, smooth. Wall composed of moderately well sorted, fine, quartz grains, with occasional larger grains conspicuous; surface smooth with a predominance of cement. Aperture of medium size; a simple, curved slit situated ventrally at the base of the septal face. Color buff to light tan.

Collecting Stations: Common at Stas. 3, 5, and 6, rare at Stas. 2 and 8.

Geographic Range: This widely ranging shallow water species is recorded from both sides of the Atlantic Ocean. It is recorded from the bay at Barnstable, Massachusetts (Phleger & Walton 1950).

Remarks: Excellent specimens were collected. Many of them,

however, showed collapsed chambers several days after mounting, and chemical decomposition near the aperture. A special figure (see fig. 5) has been made to illustrate the aperture before decomposition.

Specimens that have decomposed slightly and whose chambers have deflated are very similar to Trochammina rotaliformis (J. Wright) as illustrated by Cushman, 1920, U.S. Nat. Mus. Bull., 104(2):77, pl. 16, fig. 1 (not fig. 2).

FAMILY LAGENIDAE

Genus Lagena Walker and Jacob, 1798

In Kanmacher's ed. of Adams' Essays Micr., p. 634. Genotype: Serpula (Lagena) sulcata Walker and Jacob.

Lagena sp. aff. "L." laevigata (Reuss)

Pl. 2, fig. 7

?Fissurina laevigata Reuss, 1849, Akad. Wiss. Wien, 1:366, pl. 46, fig. 1; 1863, Sitz. Akad. Wiss. Wien, 46(1):338, pl. 6, fig. 84.
Lagena laevigata (Reuss). *1923, U.S. Nat. Mus., Bull., 104(4):28, pl. 5, figs. 1,2.

Description: Test very small (length less than 0.20 mm.), free, calcareous-perforate, smooth, subglobose, ellipsoidal in cross-section. Unilocular chamber, bilaterally convex, with slightly flattened ends. Chamber oval in outline, truncated at apertural end. Aperture a simple slit; small, narrow, elongate, terminal. Color translucent to white.

Collecting Stations: Sta. 4 (moderately common).

Geographic Range: This species has not previously been recorded

from the western Atlantic. Previously, Lagena laevigata (Reuss) has been found in abundance off the coast of the British Isles.

FAMILY POLYMORPHINIDAE

Genus Globulina d'Orbigny, 1839

Ann. Sci. Nat., 7:266. Genotype: Polymorphina (Globulina) gibba d'Orbigny.

Globulina sp. cf. G. gibba d'Orbigny

Pl. 2, fig. 6

?Globulina gibba d'Orbigny, Ann. Sci. Nat., 1826, 7(10):266, Modeles No. 63.--Jones & Chapman, 1896, Journ. Linn. Soc. Zool., 25:509-515, figs. 6,7,40.--*Cushman, 1944, Cushman Lab. Foram. Research, Sp. Pub., 12:22, pl. 3, figs. 18,19.

?Polymorphina gibba H. B. Brady. Parker and Jones, 1870, Trans. Linn. Soc., 27:216, pl. 39, figs. 2a-b.--Cushman, 1918, U.S. Geol. Surv., Bull., 676:10,52, pl. 2, fig. 4; pl. 11, fig. 5: 1922, P.P. 129-F, pp. 93,94, pl. 17, fig. 3; pl. 18, figs. 3a-b.--Plummer, 1927, Univ. Texas, Bull., 2644:122, pl. 6, figs. 8a-b.

?Polymorphina lactea (Walker and Jacob) var. diffusa Cushman, 1913, U.S. Nat. Mus., Bull., 71(3):84, pl. 41, fig. 8. (for complete synonomy see Cushman and Ozawa, 1930, U.S. Nat. Mus., Proc., vol. 77, Art. 6, p. 60).

Type Locality: Unknown.

Description: Test of medium size (length, 0.32 to 0.45 mm.), free, calcareous-perforate, subglobular, with distinct, radiate

aperture. Test nearly circular in transverse section; width/length ratio 83%. Chambers few, distinct, in nearly triserial growth plan, coarsely perforate. Sutures narrow, curved, slightly depressed from well-rounded chamber walls, distinct. Aperture small, radiate, central, slightly extended by thickening of radiate protrusions. Color translucent to white.

Collecting Stations: Stas. 5 and 6 (rare).

Geographic Range: This species has a wide geographical distribution but is usually recorded as rare. It has been reported from many stations throughout the Atlantic and Mediterranean Oceans. The many supposed varieties and synonyms of Globulina gibba d'Orbigny confuse the true range of the species. Recent specimens have been found near Ireland and in the Mediterranean Ocean (Cushman and Ozawa 1930).

Stratigraphic Range: This species has been recorded from Eocene and younger strata in Europe and the United States.

Genus Sigmomorphina Cushman and Ozawa, 1928

Contr. Cushman Lab. Foram. Research, 4:17. Genotype: Sigmomorphina yokoyamai Cushman and Ozawa.

Sigmomorphina? sp. aff. S. williamsoni (Terquem)

Pl. 2, fig. 10

?Sigmomorphina williamsoni (Terquem). Cushman, 1944, Cushman Lab. Foram. Research, Sp. Pub., 12:23, pl. 3, fig. 21.

Description: Test of medium size (length, 0.38 to 0.52 mm.), free, calcareous-perforate, with inflated chambers revolved less than 180 degrees. Initial chambers obscured, succeeding chambers elongate, final chambers inflated, smooth, with fine perforations. Sutures narrow, depressed, irregularly curved, distinct. Aperture radiate, small, terminal; very distinct crenulated grooves surrounding the aperture extend 1/8 of the way down the final chamber. Color translucent.

Collecting Stations: Sta. 6 (moderately common).

FAMILY NONIONIDAE

Genus Nonion Montfort, 1808

Conch. Syst., 1:211. Genotype: Nautilus incrassatus Fichtel and Moll.

Nonion sp.

Pl. 3, fig. 2

Description: Test of medium size (greater diameter, 0.34 to 0.36 mm.), free, calcareous-perforate, planispiral; with inflated chambers and well-rounded periphery. Chambers 7 to 10 in final whorl, very finely perforate, walls nearly translucent. Final chambers elliptical in cross-section and more inflated than preceding chambers. Umbo slightly raised, circular, surrounded by depressed, irregular chamber-wall material which joins the sutures. Sutures of medium width, impressed, curved, and distinct. Septal face curved, strongly depressed just above aperture. Aperture of medium size, simple, elongate, curved slit; median, at base of septal face. Color white.

Collecting Stations: Abundant at Stas. 4 and 8, common at Stas. 2 and 3, and rare at Stas. 1, 5, 6, 7, and 9.

Genus Nonionella Cushman, 1926

Contr. Cushman Lab. Foram. Research., 2:64. Genotype: Nonionella miocenica Cushman.

Nonionella sp. aff. N. auricula Heron-Allen and Earland, 1930

Pl. 3, fig. 1

?Nonionella auricula Heron-Allen and Earland. Cushman, 1944, Cushman Lab. Foram. Research, Sp. Pub., 12:25, pl. 3, figs. 26,27.

Description: Test of medium size (greater diameter, 0.20 to 0.65 mm.), free, calcareous-perforate, very depressed trochoid with 11 to 13 chambers in the final whorl, and rounded periphery. Chambers numerous, at least two whorls visible dorsally, only final whorl visible ventrally. Average width/height ratio of final chamber 34%. Chambers narrow, regular, slightly arcuate, ellipsoidal in cross-section, perforations fine, abundant. Sutures narrow, curved, slightly impressed or flush with the chamber wall. Umbilical region depressed, with irregular umbilical plug. Apertural face slightly arched, perforate, framed with thickened calcareous rim of the chamber walls. Aperture simple, small, narrow slit situated ventrally, at the base of the apertural face. Color light to dark gray.

Collecting Stations: Sta. 9 (common), Stas. 5 and 7 (moderately common), and Sta. 1 (rare).

Genus Elphidium Montfort, 1808

Conch. Syst. 1:15. Genotype: Nautilus macellus Fichtel and Moll.

Elphidium gunteri Cole var. galvestonensis Kornfeld, 1931

Pl. 3, fig. 7

Polystomella galvestonensis Applin (nomen nudum), 1925, Am. Assoc. Petr. Geol., Bull., 9(1):84.

Elphidium gunteri Cole var. galvestonensis *Kornfeld, 1931, Stanford Univ., Geol. Dept. Contr., 1:87, pl. 15, figs. 1-3.

Type Locality: Leland Stanford Junior University Locality No. 900; eastern end of Galveston Island at junction of pier with island, Galveston, Texas.

Description: Test of medium size (greater diameter, 0.32 to 0.41 mm.), free, calcareous-perforate, planispiral, peripheral margin well rounded. Chambers slightly inflated, regular, distinct; 10 to 12 chambers in last whorl (typically 10); chamber walls finely perforate. Sutures impressed, slightly curved, with deep interprocess pits; retral processes thin, numerous. Umbo raised, rounded, prominent. Septal face evenly rounded from periphery to umbo. Aperture multiple, of medium size; situated at the base of the septal face. Color white.

Collecting Stations: Sta. 8 (common).

Geographic Range: This species has been reported as common in the shallow, warm waters of the Gulf of Mexico along the coast of Texas and Louisiana (Kornfeld 1931).

Stratigraphic Range: This species has been recorded from the Tertiary sediments of Texas and Louisiana.

Remarks: These specimens have a rough, strong appearance due to the irregularity of the surface and its structural reinforcement in the retral processes.

Elphidium incertum (Williamson)

Pl. 3, fig. 4

Polystomella umbilicatula var. incerta Williamson, 1858, Rec. Foram. Gt. Britain, p. 44, pl. 3, figs. 82-82a.

Polystomella striato-punctata var. incerta Williamson. Kiaer, 1900, Rept. Norwegian Fish. Mar. Invest., 1(7):51.--Cushman, 1913, Rept. Canadian Arctic Exped. pt. M, p. 10.

Elphidium incertum (Williamson). *Cushman, 1930, U.S. Nat. Mus., Bull., 104(7):18, pl. 7, figs. 4-9.--*Hadley, 1936, Elisha Mitchell Sci. Soc., Jour., 52:35.--*Cushman, 1939, U.S. Geol. Surv., P.P. 191, p. 57, pl. 15, figs. 21-24; *Cushman, 1944, Cushman Lab. Foram. Reser., Sp. Publ., 12:25, pl. 3, figs. 28-31.

Description: Test of medium size (greater diameter, 0.23 to 0.31 mm.), free, calcareous-perforate, with planispiral growth plan. Last whorl composed of 7 to 9 chambers (typically 8); slightly inflated, perforate, with peripheral margin well rounded. Umbo small, irregular, frequently with nodes. Sutures narrow, impressed, curved; retral processes numerous, indistinct, interprocess pits deep, in-

distinct. Septal face rounded, perforate, impressed just above the base. Aperture multiple, of small, circular, irregular openings. Color white.

Collecting Stations: Abundant at Sta. 3, common at Stas. 1 and 2, and rare at Sta. 4.

Geographic Range: This is a widely ranging species, having been recorded from both sides of the Atlantic Ocean. Hadley reported it as rare to common at Beaufort, North Carolina.

Elphidium sp. aff. E. incertum (Williamson)
var. mexicanum Kornfeld, 1931
Pl. 3, fig. 3

?Elphidium incertum (Williamson) var. mexicanum *Kornfeld, 1931, Stanford Univ., Geol. Dept., Contr., 1(3), pl. 16, figs. 1-2.

Description: Test small (greater diameter, 0.32 to 0.40 mm.), free, calcareous-perforate, flattened planispiral with acute, rounded, peripheral margin. Last whorl composed of 10 to 11 inflated, perforate, distinct chambers; regular, with final chamber slightly larger than preceding chamber. Umbo depressed, irregularly filled with small nodes of test material. Sutures narrow, curved and impressed join umbo at depressed level. Retral processes narrow, irregular; prominent in some cases; interprocess pits on final suture hemispherical, deep and numerous, indistinct on preceding sutures. Septal face curved, perforate, thinner than chamber wall, slightly impressed above aperture. Aperture small, multiple and basal;

consisting of about 6 elliptical openings, evenly spaced at the base of the septal face. Color white.

Collecting Stations: Abundant at Sta. 6, common at Sta. 1, moderately common at Sta. 5, and rare at Stas. 2, 3, 4, and 7.

Remarks: Identification of this form has proved extremely difficult due to its variability. The characters of the specimen illustrated are similar to Elphidium articulatum (d'Orbigny) var. rugulosum Cushman & Wickenden 1929, and Elphidium incertum.

Elphidium sp.

Pl. 3, fig. 10

Description: Test of medium size (greater diameter, 0.32 to 0.42 mm.), free, calcareous-perforate, planispiral; thickness/greater diameter ratio, 31%. Chambers distinct, slightly inflated, with acute periphery; 6 to 7 chambers in the final whorl. Sutures narrow, curved, slightly impressed with distinct, wide, retral processes; inter-process pits circular, deep, numerous. Umbo small, irregular, flush with chamber wall. Aperture small, multiple, 7 to 10 circular openings, basal. Color white.

Collecting Stations: Sta. 2 (moderately common), and Sta. 5 (rare).

Elphidium n. sp.

Pl. 3, fig. 11

Description: Test of medium size (greater diameter, 0.58 mm.), free, calcareous-perforate, nearly circular, planispiral; the

thickness/greater diameter ratio 40%. Chambers of final whorl numerous, 13, slightly irregular, inflated, well-rounded periphery; perforations small, numerous, closely spaced. Sutures narrow, impressed; distinct retral processes, about 10 per chamber; interprocess pits large, oval, deep. Umbo large, prominently raised with irregular small nodes, covers lower 1/3 of chamber walls. Septal face evenly rounded, perforate. Aperture multiple, small, basal; consisting of 4 or 5 elliptically shaped openings, evenly spaced. Color white.

Collecting Stations: Sta. 8 (rare).

Comparison: Elphidium gunteri Cole var. galvestonensis Kornfeld is the closest allied species. Kornfeld has confused the new species and included it with galvestonensis (Kornfeld 1931, pl. 15, figs. 1-3). Specimens of galvestonensis have a maximum greater diameter of 0.41 mm.. This specimen is larger (0.58 mm.). Galvestonensis has a thickness/greater diameter ratio of 42%, while this specimen shows a similar ratio of 40%. The umbonal boss of galvestonensis is multiple and slightly convex. This specimen has a distinct umbonal boss, large and strongly convex, which extends laterally over the lower 1/3 of the chamber walls.

FAMILY BULIMINIDAE

Genus Buliminella Cushman, 1911

U.S. Nat. Mus., Bull., 71(2):88. Genotype: Bulimina elegantissima d'Orbigny.

Buliminella elegantissima (d'Orbigny)

Pl. 2, fig. 11

Buliminella elegantissima d'Orbigny, 1839, Voyage dans l'Amérique

méridionale, Foraminifères, 5(5):51, pl. 7, figs. 13,14.
--Cushman, 1919, U.S. Nat. Mus., Proc., 56:606; *1944, Cushman Lab. Foram. Research, Sp. Pub., 12:27, pl. 3, figs. 43,44; *U.S. Geol. Surv., P.P. 210-D, pp. 67-68, pl. 17, figs. 10-12, (with complete synonymy).

Type Localities: Paita, Peru; Cobija, "Bolivia" (Peru? or Chile?); Valparaiso, Chile.

Description: Test very small (length, 0.23 to 0.40 mm.), free, calcareous, elliptical in outline, fusiform; consisting of about 2 whorls with 9 to 11 chambers in the last whorl. Width/length ratio 38% to 43% (typically 42%). Chambers of last whorl elongate, rounded, arcuate, regular, and distinct, with final chamber slightly larger than penultimate chamber, chamber wall slightly perforate. Sutures narrow, slightly impressed, curved. Septal face depressed and elongate, extending 1/3 length of test. Aperture small, simple, narrow slit at the top of the apertural face. Color white to light tan, typically translucent.

Collecting Stations: Sta. 4 (abundant) and 6 (moderately common).

Geographic Range: This species occurs in both fossil and Recent material. It was described from Recent material at Paita, Peru, Cobija, in Peru or Chile, and Valparaiso, Chile. It has been described from fossil material in the Eocene, Wilcox Group, of Alabama, the Jackson Group of Texas and Louisiana, and the Pliocene of Florida. (For a complete stratigraphic and geographic range of this species see

U.S. Geol. Surv., P.P. 210-D, p. 68.)

Remarks: The occurrence of Buliminella elegantissima (d'Orbigny) in Mason Inlet is important ecologically. Previously, it has been recorded from Florida and the New England coast. In New England it has been recorded off Nonamesset Island and Vineyard Sound, Massachusetts. Further brackish water studies of foraminifera will undoubtedly complete this range along the western Atlantic coast.

Genus Bulimina d'Orbigny, 1826

Ann. Sci. Nat., 7:269. Genotype: Bulimina marginata d'Orbigny

Bulimina sp.

Pl. 2, fig. 8

Description: Test of medium size (length, 0.40 to 0.42 mm.), free, calcareous-perforate, elongate, nearly triserial. Chambers inflated, well rounded, smooth, with thickened, short, protrusive spines, pointing away from the aperture; maximum width/length ratio 65%. Sutures distinct, narrow, impressed, curved. Apertural face depressed, smooth trough with angular periphery at the chamber wall. Aperture of medium size, simple, loop shaped; depressed from the base of the apertural trough. Color translucent to white.

Collecting Stations: Sta. 4 (rare).

Genus Bolivina d'Orbigny, 1839

Voy. Amer. Merid., 5(5):61. Genotype: Bolivina plicata d'Orbigny.

Bolivina subaenariensis Cushman, 1922

Pl. 3, fig. 5

Bolivina subaenariensis *Cushman, 1922, U.S. Nat. Mus., Bull., 104(3):46, pl. 7, fig. 6; *1944, Cushman Lab. Foram. Research, Sp. Pub., 12:29-30, pl. 4, fig. 6.--*Parker, 1948, Mus. Comp. Zool., 100(2):237, pl. 5, fig. 17.

Type Locality: Off coast of Nantucket in 250 fathoms.

Description: Test of medium size (length, 0.29 to 0.44 mm.), free, calcareous-perforate with biserial growth plan throughout. Chambers slightly inflated, well-rounded periphery, with marginal edge thickened and well rounded, peripheral edge pointed away from the aperture. Angle between suture and lateral axis about 50 degrees. Sutures narrow, depressed, slightly curved, regular. Aperture of medium size; a slightly curved slit, centrally situated and upright on the final chamber, extending downward to the top of the preceding chamber. Basal 1/3 of test ornate with fine striae. Color translucent to light tan.

Collecting Stations: Stas. 1, 6 (moderately common), Sta. 9 (rare).

Geographic Range: This species has been found along the coast of Nantucket, usually in the deeper water. A specimen was found in shallow water off the coast of Trials Island, Eastport, Maine.

Genus Reussella Galloway, 1933

Man. Foram., p. 360. Genotype: Verneuilina spinulosa Reuss.

Reusella sp.

Pl. 3, fig. 8

Description: Test small (length, 0.22 to 0.34 mm.), free, calcareous-perforate, with triangular-shaped chambers arranged in a triserial plan of growth. Chambers regular, triangular in cross-section with sides slightly concave, periphery acute; arranged in 6 to 7 whorls or tiers with each tier overlapping the previous one with sharp barbs. Chamber walls concave, smooth, with medium-sized pores throughout. Final whorl overlaps penultimate whorl by 2/3 the chamber height. Sutures impressed, narrow, distinct. Aperture an irregular slit at the margin of the last chamber, hidden by broken lip or protrusion. One specimen ornate with short spinose protrusions at the periphery. Color translucent tan.

Collecting Stations: Stas. 5 and 6 (rare).

Genus Uvigerina d'Orbigny, 1826

Ann. Sci. Nat., 7:268. Genotype: Uvigerina pigmea d'Orbigny.

Uvigerina sp.

Pl. 3, fig. 6

Description: Test very small (length 0.31 to 0.39 mm.), free, calcareous-perforate, elongate, width/length ratios 45% to 47% (typically 45%). Chambers slightly inflated, elongate, triserial, nearly circular in cross-section; final chamber somewhat triangular in cross-

section; final chamber somewhat triangular in cross-section, slightly concave at the periphery. Sutures distinct, thin, impressed. Aperture small, terminal, circular and produced at the apex of the last chamber. Color white.

Collecting Stations: Stas. 1, 5, and 6 (rare).

FAMILY ROTALIIDAE

Genus Discorbis Lamarck, 1804

Ann. Mus., 5:183. Genotype: Discorbis vesicularis Lamarck.

Discorbis sp.

Pl. 3, fig. 9

Description: Test small (greater diameter, 0.27 to 0.29 mm.), apparently attached, calcareous-perforate, extremely depressed trochoid, consisting of about 2¼ whorls of plano-convex chambers, rounded dorsally. Initial coil barely discernable, last whorl with 8 chambers. Chambers flattened, slightly enlarged, rounded dorsally, flat to concave ventrally; final chamber twice as large as succeeding chamber; perforations fine, numerous. Sutures oblique, limbate or depressed irregularly, typically thin, slightly curved. Umbilicus large, depressed, prominent. Septal face basally rounded at the margin, just above thin fold. Aperture simple, small, narrow slit; ventrally situated at the base of the last chamber. Color light tan to brown.

Collecting Stations: Sta. 4 (moderately common), and Sta. 5 (rare).

Genus Eponides Montfort, 1808

Conch. Syst., 1:127. Genotype: Nautilus repandus Fichtel and Moll.

Eponides sp. aff. E. wrightii (H. B. Brady)

Pl. 4, fig. 3

Eponides wrightii (H. B. Brady). *Cushman, 1931, U.S. Nat. Mus., Bull., 104(8):56, pl. 11, figs. 7,8.

Description: Test small (greater diameter, 0.21 to 0.27 mm.), free, calcareous-perforate, high-spired trochoid. Greater diameter/height ratio 87% to 93% (typically 92%). Consisting of about 3¼ whorls, with initial coil indistinct; 7 to 9 chambers in last whorl; very finely perforate. Peripheral margin acutely rounded. Umbilicus filled by chamber extensions from the last whorl. Sutures thin, slightly curved and impressed. Septal face rounded, smooth. Aperture a small, thin, curved slit at base of apertural face, ventral. Color white.

Collecting Stations: Stas. 2, 7, and 8 (rare).

Remarks: This specimen differs from Eponides wrightii (H. B. Brady) in having neither an umbilical plug nor beads in radial lines along the ventral sutures.

Genus Poroeponides Cushman, 1944

Cushman Lab. Foram. Research, Sp. Pub., 12:34. Genotype: Rosalina lateralis Terquem.

Poroeponides repanda (Fichtel & Moll)

Pl. 4, fig. 1

Nautilus repandus Fichtel & Moll, 1798, Test. Micro., p. 35, pl. 3, figs. a-d.

Eponides repandus Montfort, 1808, Conch. Syst., 1:127, 32e genre.

Pulvinulina repanda (Fichtel & Moll). *Carpenter, Parker and Jones. 1862, Introd. Foram., p. 210.--*Cushman, 1925, Cushman Contr. Foram. Research., 1(2):43.--Hanzawa, 1925,1926, Jour. Geol. Pal., 4:44.

Rotalia repanda (Fichtel & Moll). *Shupack, 1934, Am. Mus. Novit., No. 737, p. 7.

Eponides repanda (Fichtel & Moll), *Cushman, 1931, U.S. Nat. Mus., Bull., 104(8):49, pl. 10, figs. 7a-c.

Type Locality: Unknown.

Description: Test large (greater diameter, 0.67 to 1.05 mm.), free, calcareous-perforate, depressed trochoid, unevenly biconvex. Initial coil well defined, flat; subsequent chambers distinct and regular, usually about 1 3/4 whorls in the adult; last whorl with 7 chambers, nearly triangular in cross-section, very finely perforate. Deep umbilical cavity along base of last 2 or 3 chambers and into base of septal face. Septal face only slightly curved and offset about 30 degrees from longitudinal axis; large pores, possibly secondary

apertures, are scattered over the septal face. Sutures wide, distinct, raised, slightly curved, join the heavy keel without interruption. The clear keel follows the curved outline of the youngest chambers, but is angular and thickened in the first 1½ whorls. Aperture a simple, curved slit at the base of the septal face, widening toward the periphery and terminating against the inside margin of the keel. Wall white, distinct from translucent sutures.

Collecting Stations: Stas. 5, 6 (common), 7, and 9 (moderately common).

Geographic Range: Poroeponides repanda has a wide range throughout the warm water zones of the Atlantic Ocean. It is abundant in the open sea at Kure Beach, south of Wilmington.

Remarks: This species is the largest calcareous foraminifer found in the Mason Inlet region.

Genus Rotalia Lamarck, 1804

Ann. Mus., 5:184. Genotype: Rotalia trochidiformis Lamarck.

"Rotalia" sp. cf. "R." beccarii (Linne)

Pl. 4, fig. 2

?Nautilus beccarii Linne, 1767, Syst. Nat., ed. 12, p. 1162; ed. 13 (Gmelin's) 1788, p. 3370.

?Streblus beccarii Fischer, 1819, Advers. Zool. fasc. 2, p. 75.

?Discobula ariminensis Lamarck, 1816, Tabl. Encycl. et Meth., pl. 466, figs. 6a,b.

?Rotalina beccarii (Linne). Williamson, 1858, Rec. Foram. Gt. Britain, p. 48, pl. 4, figs. 90-92.

Rotalia beccarii (Linne). *Cushman, 1931, U.S. Nat. Mus., Bull., 104(8):58, pl. 13, figs. 1a-c; *1944, Cushman Lab. Foram. Research, Sp. Pub., 12:35, pl. 4, figs. 22a,b.

Type Locality of Rotalia beccarii: Rimini, Italy.

Description: Test of medium size (greater diameter, 0.28 to 0.48 mm.), free, calcareous-perforate, depressed trochoid, with inflated chambers, unevenly biconvex, and well rounded periphery. Typically $3\frac{1}{4}$ to 3 3/4 whorls in the adult, consisting of a distinct initial whorl, usually of 8 chambers, and a last whorl of 7 to 8 chambers. Chambers inflated, distinct, unevenly biconvex, intensely perforate. Umbilical region irregular, typically hollow but frequently modified by extensions of the chamber wall. Sutures narrow, impressed, curved, slightly inclined. Septal face rounded, perforate, ventral; slightly raised and produced at the base forming an apertural lip. Aperture of medium size; a simple, curved, slit ventrally situated at the base of the septal face. Color light tan.

Collecting Stations: Abundant at Stas. 4 and 6, common at 5 and 7, moderately common at Stas. 1, 3, and 8, and rare at Stas. 2 and 9.

Geographical Range: This is a very common species, having been recorded from nearly the entire Atlantic Ocean. It has been recorded as a shallow water species along the New England coast by Cushman,

and in New York Harbor by Shupack. The varieties tepida and parkinsoniana of this species have also been found by Hadley at Beaufort, North Carolina.

Remarks: Due to the presumed variation in Rotalia beccarii, no attempt was made to separate these specimens according to described varieties.

FAMILY GLOBIGERINIDAE

Genus Globigerinoides Cushman, 1927

Contr. Cushman Lab. Foram. Research, 3:87. Genotype: Globigerina rubra d'Orbigny.

Globigerinoides sp. cf. G. rubra d'Orbigny, 1839

Pl. 4, fig. 5

?Globigerina rubra d'Orbigny, 1893, in de la Sagra, Hist. Fis. Pol. Nat. Cuba. "Foraminiferes", p. 94, pl. 4, figs. 12-14.--H. B. Brady, Parker and Jones, 1888, Trans. Zool. Soc. London, 12:225, pl. 45, fig. 12.--Cushman, 1914, U.S. Nat. Mus., Bull., 71(4):9, pl. 3, figs. 6-9; *1924, Bull., 104(5):15, pl. 3, figs. 4-7.

Type Locality of Globigerina rubra: West Indian Ocean.

Description: Test of medium size (greater diameter, 0.20 to 0.45 mm.), free, calcareous-perforate, depressed trochoid with final chambers nearly spherical. Initial coil indistinct, typically 3 chambers in the last whorl. Final chambers rounded, oval with coarse perforations numerous; depressions from remnant spine sockets distinct, large in comparison to the test. Sutures narrow, depressed, distinct

on final chambers. Aperture large, simple; highly arched at the inner margin of the chamber, with a thin, smooth lip circumventing the opening. Color very light tan, translucent. These specimens were tinted pink and tan, when first observed, one week after collection.

Collecting Stations: Very abundant at Sta. 6, common at Stas. 5 and 7, moderately common at Stas. 1 and 4, and rare at Sta. 2.

Geographic Range: This pelagic species is recorded from both sides of the Atlantic Ocean, the West Indian Ocean and the Caribbean Sea in abundance. The warm Gulf Stream of the Gulf of Mexico frequently produces specimens with bright colored tests.

Remarks: Some of the specimens appear to be reworked material. Station 4 has yielded specimens less than 0.2 mm. in their greater diameter.

Genus Globigerinella Cushman, 1927

Contr. Cushman Lab. Foram. Research, 3:87. Genotype: Globigerina aequilateralis H. B. Brady.

Globigerinella sp.

Pl. 4, fig. 4

Description: Test small (greater diameter, 0.24 to 0.31 mm.), free, calcareous-perforate, with planispiral growth plan of inflated, spheroidal chambers. Adult test of 2 whorls with 5 to 7 chambers in the final whorl. Chambers of medium size, globular, regular, distinct; chamber wall ornate with numerous, short, thin spines. Sutures distinct, narrow, impressed, nearly straight. Apertural

face rounded, spine free; slight protrusion near base of septal face. Aperture simple, medium sized, basal, central, highly arched opening completely overlain by apertural lip. Color white, light tan and light brownish red.

Collecting Stations: Sta. 4 (abundant).

FAMILY ANOMALINIDAE

Genus Planulina d'Orbigny, 1826

Ann. Sci. Nat., 7:280. Genotype: Planulina ariminensis d'Orbigny.

Planulina caribaea Cushman, 1931

Pl. 4, fig. 6

Planulina caribaea *Cushman, 1931, U.S. Nat. Mus., Bull., 104(8):112, pl. 20, figs. 1a-c.

Type Locality: Montego Bay, Jamaica, West Indies.

Description: Test of medium size (greater diameter, 0.38 mm.), free, calcareous-perforate, very depressed trochoid initially, with youngest chambers expanded irregularly and flattened. Initial coil of 7 chambers visible dorsally, final whorl of 6 to 7 chambers. About $2\frac{1}{2}$ whorls in the adult, with final whorl incomplete in regular trochoid pattern due to expansion of last 3 chambers. Chambers slightly inflated, coarsely perforate, regular in first two whorls. Sutures thin, curved, impressed, and oblique. Peripheral margin acute with slight keel. Aperture simple, curved, narrow, ventral slit at base of final chamber. Color tan to white.

Collecting Stations: Sta. 7 (rare).

Geographic Range: This species has been recorded from many regions of the West Indies, especially near Jamaica. It has also been reported in the eastern Atlantic Ocean.

Remarks: The description of this species given by Cushman (1931) states that the initial whorls are planispiral. This specimen, although nearly planispiral, is a very depressed trochoid in which the umbilicus is comparable to the ventral depression discussed by Cushman. This is the northernmost occurrence of the species in the western Atlantic Ocean and represents a northern extension in the geographic range.

Genus Cibicides Montfort, 1808

Conch. Syst., 1:123. Genotype: Cibicides refulgens Montfort.

Cibicides sp. cf. C. concentrica (Cushman)

Pl. 4, fig. 8

?Truncatulina concentrica Cushman, 1918, U.S. Geol. Surv., Bull., 676, p. 64, pl. 21, fig. 3.

Cibicides concentrica *(Cushman), 1931, U.S. Nat. Mus., Bull., 104(8):120, pl. 21, figs. 4,5; pl. 22, figs. 1,2.--*Parker, 1948, Mus. Comp. Zool., 100(2):237, pl. 1, figs. 16a,b (check list and figure only).

Type Locality of Truncatulina concentrica: One mile south of Red Bay, Florida.

Description: Test of medium size (greater diameter, 0.68 to 0.70 mm.), free, calcareous-perforate, trochoid of highly inflated chambers unevenly biconvex with well-rounded periphery. Initial coil hidden by subsequent whorls, 7 to 8 chambers in the final whorl of meglospheric form. Sutures narrow and nearly straight dorsally, curved ventrally, slightly impressed. Septal face slightly curved, framed by thin perforate lens of test meterial, thinner than walls. Aperture simple, medium, curved slit at base of septal face, slightly dorsal, nearly hidden under depressed septal face. Color light gray to tan.

Collecting Stations: Sta. 9 (common), Stas. 5 and 7 (moderately common), and Stas. 1 and 6 (rare).

Geographic Range: This is a common warm water species along the coast of Florida and nearby areas.

Stratigraphic Range: This species has been recorded from the Miocene of Florida, in the Choctawhatchee marl.

Remarks: Many of these specimens are discolored and show abrasion. These may be fossil specimens. However, several of the specimens, including the one figured, are not discolored and do not show wear.

Cibicides floridanus (Cushman)

Pl. 4, fig. 7

Truncatulina floridana Cushman, 1918, U.S. Geol. Surv., Bull., 676, p. 62, pl. 19, figs. 2a-c.--Nuttall, 1928, Quart. Journ. Geol. Soc., 84:98, pl. 7, figs. 14,16.

Cibicides floridana Cushman, 1930, Fla. Geol. Surv., Bull., 4, p. 61, pl. 12, figs. 3a-c; *1931, U.S. Nat. Mus., Bull., 104(8):122, pl. 23, figs. 3-5.

Type Locality: Choctawhatchee marl of Florida.

Description: Test of medium size (greater diameter, 0.65 mm.), free, calcareous-perforate, depressed trochoid; rounded ventrally, flattened dorsally, with peripheral margin acute and rounded. About $2\frac{1}{2}$ whorls in the adult, consisting of 11 to 12 chambers in the last whorl, very finely perforate, inflated ventrally and evenly rounded from margin to umbilical plug; chamber walls roughened by wrinkled surface of small rounded nodes, wrinkled surface also present internally. Umbilical plug large, smooth, and rounded. Sutures thin, impressed, curved, regular but not pronounced ventrally; curved, impressed, pronounced dorsally. Aperture medium sized, simple, arched slit; situated centrally at the base of the septal face, ventral. Color light tan.

Collecting Stations: Stas. 1 and 9 (rare).

Geographic Range: This species has been recorded by Cushman as common along the coast of Florida.

Stratigraphic Range: Cibicides floridanus has been described from the Miocene beds of the Choctawhatchee marl of Florida and from the Miocene of the Vienna Basin.

Cibicides sp. cf. C. refulgens Montfort, 1808

Pl. 3, fig. 12

?Cibicides refulgens Montfort, 1808, Conch. Syst., 1:122.

--*F. L. Parker, 1948, Mus. Compar. Zool., Bull., 100, no. 2, pl. 6, figs. 10a,b.

?Truncatulina refulgens (Montfort). d'Orbigny, 1826, Ann. Sci. Nat., 7:279, pl. 13, figs. 8-11.--Heron-Allen and Earland, 1930, Jour. Roy. Micr. Soc., p. 187.

Type Locality: Not designated.

Description: Test of medium size (greater diameter, 0.32 to 0.47 mm.), apparently attached, calcareous-perforate, depressed trochoid, plano-convex, flattened dorsally, peripheral margin acute. About $2\frac{1}{2}$ whorls in the adult, 6 chambers in the initial whorl, 9 chambers in the second whorl, and 9 in the final whorl. Chambers slightly inflated, regular in the first 2 whorls, slightly irregular in the final whorl; final chamber $1\frac{1}{4}$ times as high as preceding chamber. Perforations coarse, very closely spaced, numerous. Sutures thin, curved, impressed, and inclined dorsally, inclined to a lesser degree ventrally. Umbilical region filled by inner margin of chambers in the last whorl. Septal face smoothly rounded and perforate. Aperture broken. Color light tan.

Collecting Stations: Stas. 2, 5, and 6 (rare).

Geographic Range: This is a widely ranging species which has been reported from many stations in the Atlantic Ocean.

Stratigraphic Range: Cibicides refulgens has been reported as fossil from Tertiary strata of the United States.

Genus Dyocibicides Cushman and Valentine, 1930

Stanford Univ., Geol. Dept. Contr., 1(1):30. Genotype: Dyocibicides biserialis Cushman and Valentine.

?Dyocibicides biserialis Cushman & Valentine

Description: Test of medium size (length, 0.42 mm.), free, calcareous-perforate; consisting of an initial trochoid coil of about 1 3/4 whorls and a final whorl with irregular chamber growth. Chambers distinct and regular in initial whorl; later chambers inflated, coarsely-perforate, arcuate. Peripheral margin variable; rounded in early whorls, acute in final chambers. Irregular chambers without definite shape, coarsely-perforate and situated ventrally at the periphery of the final whorl. Sutures of early whorls narrow, strongly curved, impressed, distinct, variable in irregular chambers. Major portion of irregular growth ventral. Aperture simple slit, of medium size, situated ventrally at the base of final irregular chamber. Color light tan to translucent.

Collecting Stations: Sta. 7 (rare).

Remarks: A single specimen has been found of a Cibicides-like form that may be identical with that referred by Hadley (1936) to Dyocibicides biserialis. The specimen is almost certainly teratological, and may belong to one of the species of Cibicides.

FAMILY PLANORBULINIDAE

Genus Planorbulina d'Orbigny, 1826

Ann. Sci. Nat., 7:280. Genotype: Planorbulina mediterranensis d'Orbigny.

Planorbulina mediterranensis d'Orbigny, 1826

Pl. 3, fig. 13

Planorbulina mediterranensis d'Orbigny, 1826, Ann. Sci. Nat., 7:280, no. 2, pl. 14, figs. 4-6.--H. B. Brady, 1884, Rep. Voy. Challenger, Zool., 9:656, pl. 92, figs. 1-3.--Heron-Allen and Earland, 1930, Journ. Roy. Micr. Soc., p. 186.--*Cushman, 1931, U.S. Nat. Mus., Bull., 104(8):129,130, pl. 24, figs. 5-8.

Type Locality: Mediterranean Sea.

Description: Test of small size (length, 0.32 to 0.37 mm.), apparently attached, calcareous-perforate, with initial coil of at least 2 whorls, depressed; final chambers irregularly situated, flattened. Chambers of apiral medium sized, slightly inflated, rounded and regular, dorsally; obscure ventrally. Succeeding chambers similar but irregularly situated about the periphery of the spiral. All chambers visible dorsally, irregular chambers visible in part ventrally. Perforations large and numerous. Umbilical region depressed. Sutures narrow, depressed, well defined dorsally, partially obscured ventrally. Aperture medium sized, 1 visible, situated on the periphery, extending dorsally and ventrally, overlain by narrow, curved, protruding lip. Color light tan in the inner whorl, white otherwise.

Collecting Stations: Sta. 6 (rare).

Geographic Range: This species is widely distributed in the eastern Atlantic Ocean from Norway to Spain and in the Mediterranean and Indo-Pacific Oceans. In the western Atlantic the species has been recorded from the coast of Florida, the West Indies, and Brazil.

Remarks: This seems to be the first occurrence of the species, on the western Atlantic coast, north of Florida. The presence of Planorbulina mediterranensis d'Orbigny in Mason Inlet extends its geographic range approximately 300 miles north.

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Plate 1.

Recent foraminifera from Mason Inlet, North Carolina. (Magnifications approximate.)

Fig. 1-3. "Ammobaculites" cassis (Parker), Sta. 8; X48. 1a, 2a, 3a, lateral views. 1b, apertural view. 3b, end view. (Page 29.)

Fig. 4. Textularia cf. parvula Cushman, Sta. 8; X48. 4a, lateral view. 4b, apertural view. (Page 31.)

Fig. 5. Haplophragmoides sp., Sta. 8; X36. 5a, dorsal view. 5b, apertural view. (Page 28.)

Fig. 6. Reophax sp., Sta. 4; X48. 6a, lateral view. (Page 28.)

Fig. 7. Triloculina cf. brevidentata Cushman, Sta. 5; X36. 7a, 7c, lateral views. 7b, apertural view. (Page 39.)

Fig. 8. Quinqueloculina lamarckiana d'Orbigny, Sta. 7; X36. 8a, 8c, lateral views. 8b, apertural view. (Page 33.)

Fig. 9. Spiroloculina planulata (Lamarck), Sta. 5; X27. 9a, lateral view. 9b, apertural view. (Page 38.)

Fig. 10. Milliammina fusca (Brady), Sta. 8; X36. 10a, 10b, lateral views. (Page 32.)

Fig. 11. Miliolinella? sp., Sta. 7; X36. 11a, 11c, lateral views. 11b, apertural view. (Page 37.)

PLATE I

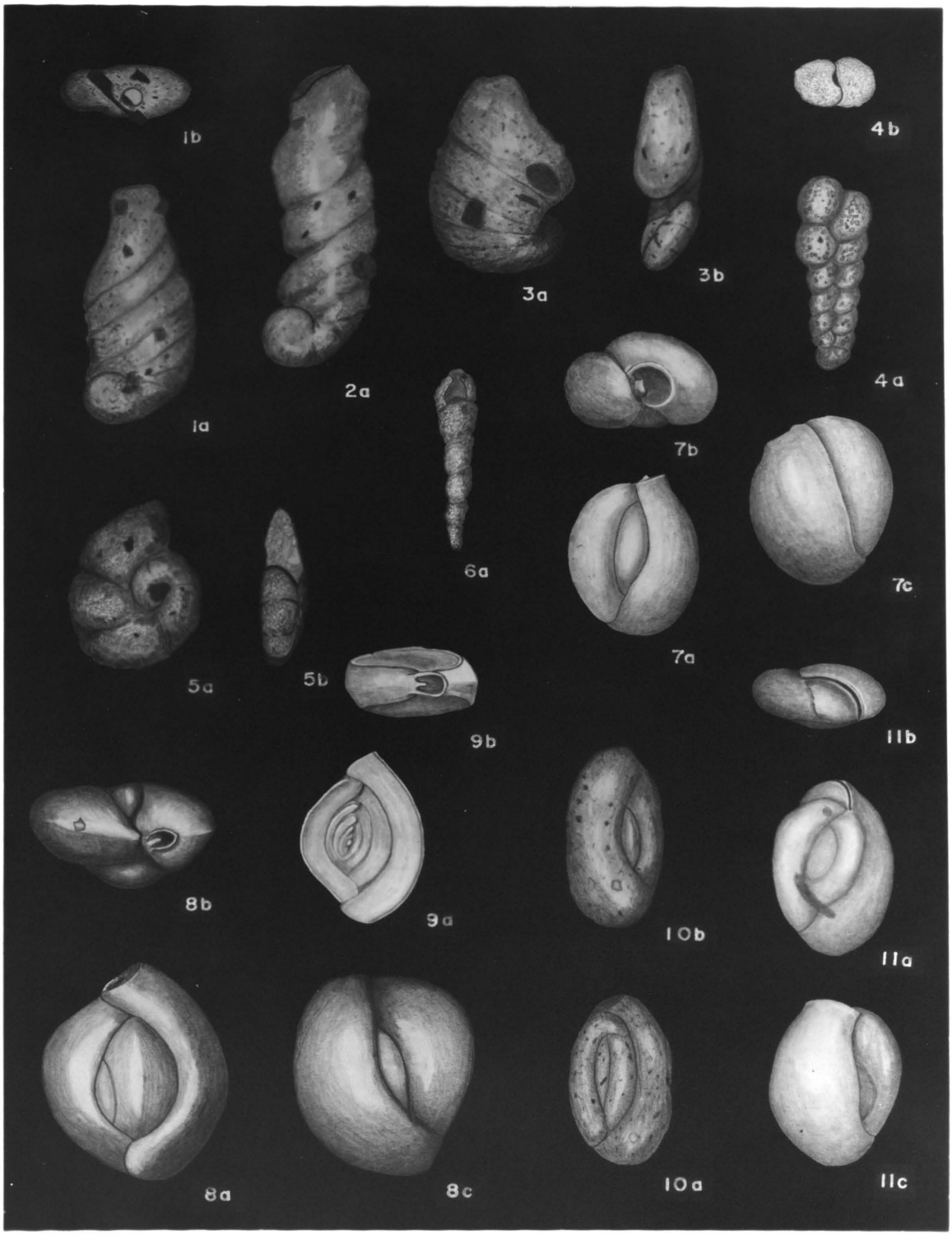
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Plate 2

Recent foraminifera from Mason Inlet,
North Carolina. (Magnifications approximate.)

Fig. 1. Quinqueloculina cf. seminulum (Linné), Sta. 9; X36. 1a, 1c, lateral views. 1b, apertural view. (Page 35.)

Fig. 2. Quinqueloculina poeyana d'Orbigny, Sta. 5; X27. 2a, 2c, lateral views. 2b, apertural view. (Page 34.)

Fig. 3. Planispirina auriculata Egger, Sta. 1; X48. 3a, oblique lateral view. (Page 41.)

Fig. 4. Cornuspira? sp., Sta. 1; X48. 4a, dorsal view. 4b, apertural view. (Page 40.)

Fig. 5. Quinqueloculina seminulum (Linné) var. jugosa Cushman, Sta. 1; X36. 5a, 5c, lateral views. 5b, apertural view. (Page 36.)

Fig. 6. Globulina cf. gibba d'Orbigny, Sta. 5; X36. 6a, lateral view. 6b, apertural view. (Page 45.)

Fig. 7. Lagena sp. aff. "L." laevigata (Reuss), Sta. 4; X60. 7a, lateral view. 7b, apertural view. (Page 44.)

Fig. 8. Bulimina sp., Sta. 4; X36. 8a, lateral view. (Page 55.)

Fig. 9. Trochammina inflata (Montagu), Sta. 5; X36. 9a, dorsal view. 9b, ventral view. Text fig. 5, apertural view. (Page 42.)

Fig. 10. Sigmomorphina? aff. williamsoni (Terquem), Sta. 6; X36. 10a, 10c, lateral views. 10b, apertural view. (Page 46.)

Fig. 11. Buliminella elegantissima (d'Orbigny), Sta. 4; X60. 11a, lateral view. (Page 53.)

PLATE 2

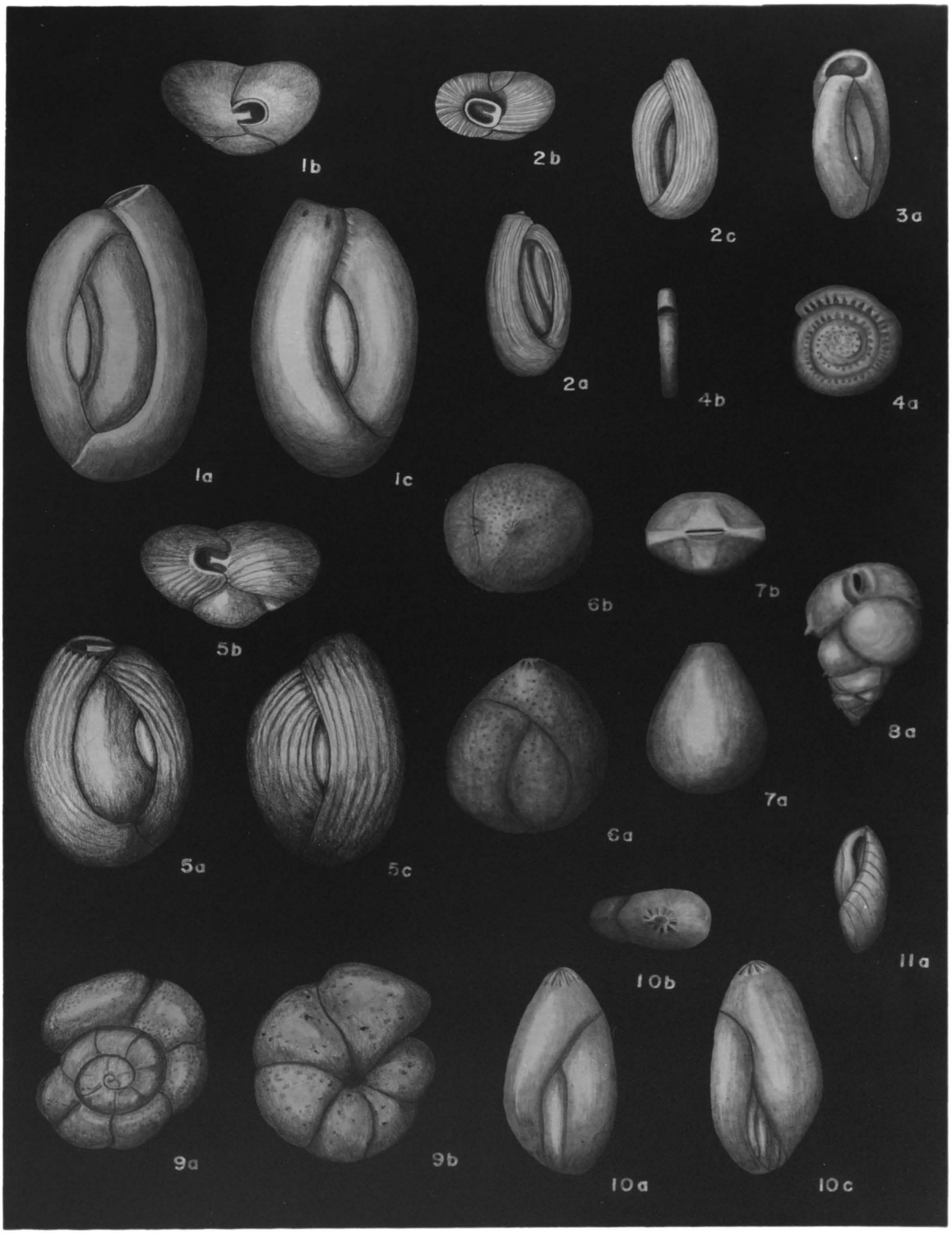
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Plate 3

Recent foraminifera from Mason Inlet,

North Carolina. (Magnifications approximate.)

Fig. 1. Nonionella aff. auricula Heron-Allen and Earland, Sta. 9; X27. 1a, dorsal view. 1b, apertural view. 1c, ventral view. (Page 48.)

Fig. 2. Nonion sp., Sta. 8; X48. 2a, lateral view. 2b, apertural view. (Page 47.)

Fig. 3. Elphidium aff. incertum (Williamson) var. mexicanum Kornfeld, Sta. 5; X48. 3a, lateral view. 3b, apertural view. (Page 51.)

Fig. 4. Elphidium incertum (Williamson), Sta. 4; X48. 4a, lateral view. 4b, apertural view. (Page 50.)

Fig. 5. Bolivina subaenariensis Cushman, Sta. 6; X48. 5a, lateral view. 5b, apertural view. (Page 56.)

Fig. 6. Uvigerina sp., Sta. 6; X60. 6a, lateral view. 6b, apertural view. (Page 57.)

Fig. 7. Elphidium gunteri Cole var. galvestonensis Kornfeld, Sta. 8, X60. 7a, lateral view. 7b, apertural view. (Page 49.)

Fig. 8. Reusella sp., Sta. 6; X48. 8a, lateral view. 8b, apertural view. (Page 57.)

Fig. 9. Discorbis sp., Sta. 5; X36. 9a, dorsal view. 9b, ventral view. 9c, end view. (Page 58.)

Fig. 10. Elphidium sp., Sta. 2; X48. 10a, lateral view. 10b, apertural view. (Page 52.)

Plate 3 (Cont.)

Fig. 11. Elphidium n. sp., Sta. 8; X27. 11a, lateral view. 11b, apertural view. (Page 52.)

Fig. 12. Cibicides cf. refulgens Montfort, Sta. 5; X36. 12a, dorsal view. 12b, end view. 12c, ventral view. (Page 69.)

Fig. 13. Planorbulina mediterranensis d'Orbigny, Sta. 6; X48. 13a, dorsal view. 13b, ventral view. (Page 71.)

PLATE 3

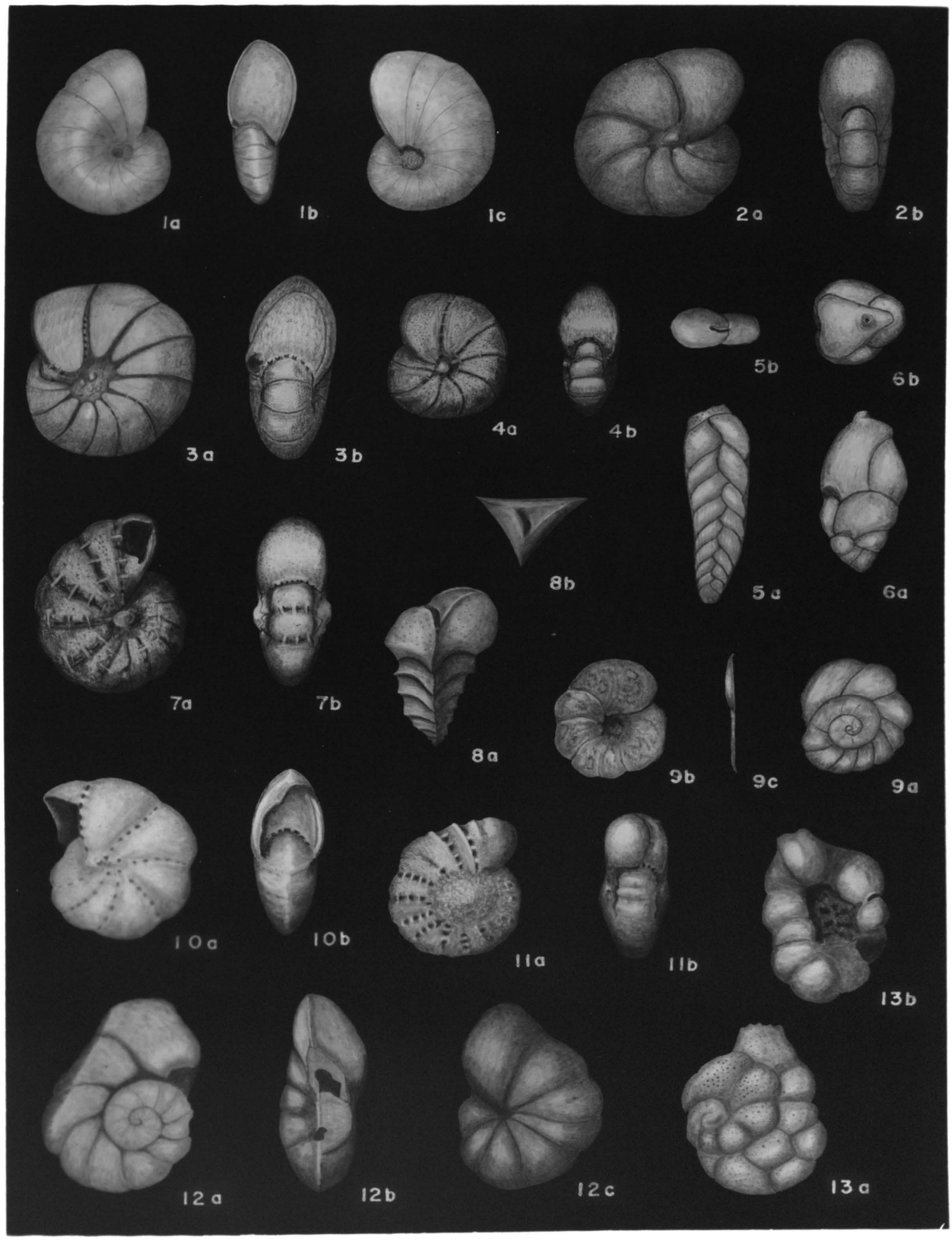
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Plate 4

Recent foraminifera from Mason Inlet, North Carolina. (Magnifications approximate.)

Fig. 1. Poroeponides repanda (Fichtel and Moll), Sta. 9; X27. 1a, dorsal view. 1b, end view. 1c, ventral view. (Page 60.)

Fig. 2. "Rotalia" cf. beccarii (Linné), Sta. 8; X48. 2a, dorsal view. 2b, apertural end view. 2c, ventral view. (Page 61.)

Fig. 3. Eponides aff. wrightii (H. B. Brady), Sta. 8; X60. 3a, dorsal view. 3b, end view. 3c, ventral view. (Page 59.)

Fig. 4. Globigerinella sp., Sta. 4; X60. 4a, lateral view. 4b, apertural view. (Page 64.)

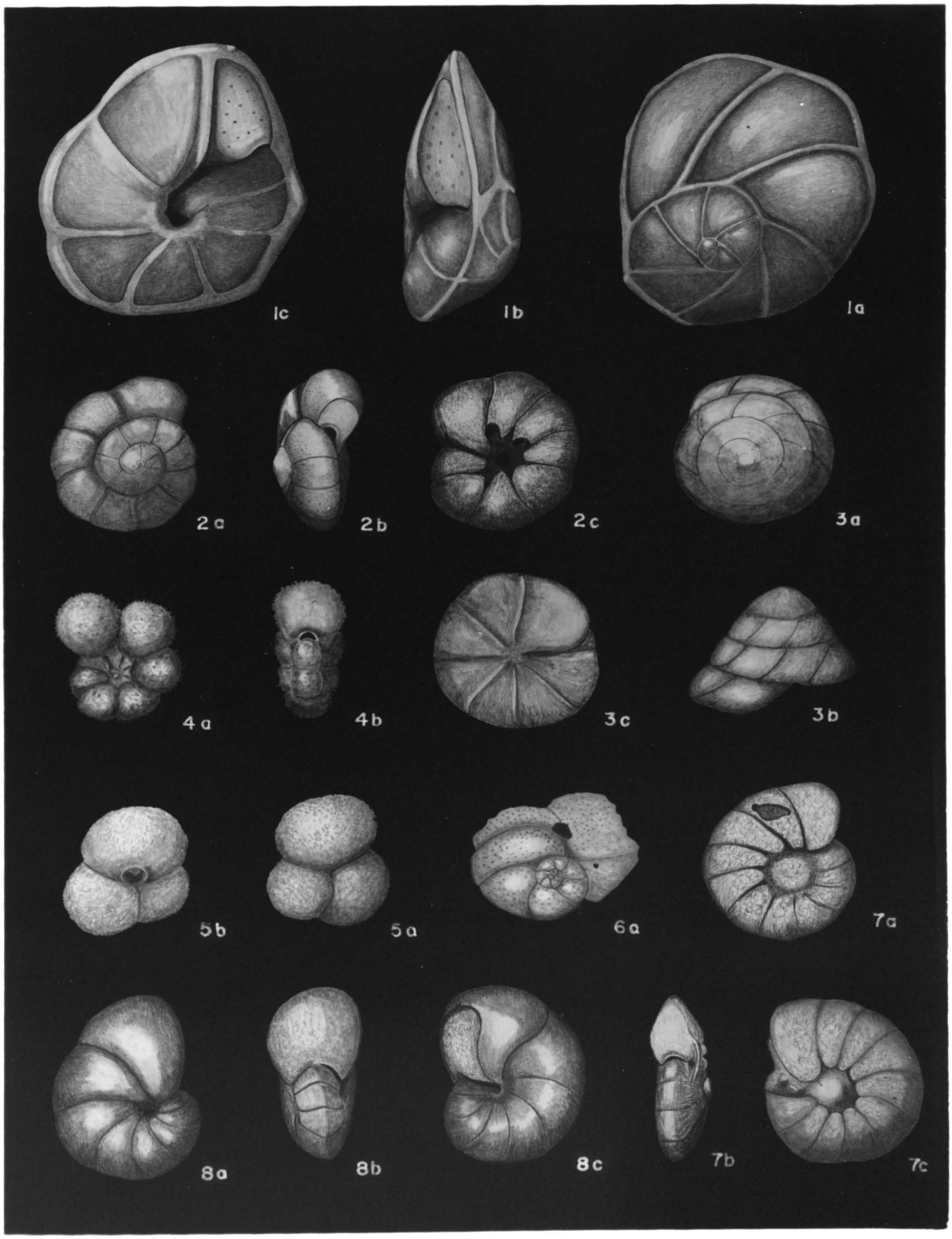
Fig. 5. Globigerinoides cf. rubra d'Orbigny, Sta. 5; X36. 5a, lateral view. 5b, apertural view. (Page 63.)

Fig. 6. Planulina caribaea Cushman, Sta. 7; X36. 6a, dorsal view. (Page 65.)

Fig. 7. Cibicides floridanus (Cushman), Sta. 9; X27. 7a, dorsal view. 7b, slightly oblique end view. 7c, ventral view. (Page 67.)

Fig. 8. Cibicides cf. concentrica (Cushman), Sta. 9; X27. 8a, dorsal view. 8b, end view. 8c, ventral view. (Page 66.)

PLATE 4



VITA

Daniel Newton Miller, Jr. was born August 22, 1924 in St. Louis, issouri. He received his elementary education in the St. Louis rea and graduated from Ferguson Senior High School in June, 1942. is initial enrollment in Missouri School of Mines and Metallurgy as in September of that year.

He served 3½ years in the Army Air Forces as a First Lieutenant ombat pilot in the Pacific Theater from 1943 to 1946.

In 1947 he returned to Missouri School of Mines and Metallurgy nd graduated in August, 1949, receiving a Bachelor of Science degree n Geology. He enrolled as a Graduate Student in September, 1949 nd was awarded a Research Fellowship in Geology from February to ugust, 1950. In September of 1950 he received a Graduate Assistant-hip in Geology which aided him in the completion of this thesis.